THE TELEGRAPHIC JOURNAL AND

ELECTRICAL REVIEW.

VOL. XXVI. FEBRUARY 7, 1890. No. 637.

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ELECTRIC TRACTION BY ACCUMULATORS.

IN our issue of the 17th ult. we announced that electric traction at Barking had turned out a commercial success, and that the official figures, as shown to our representative, really indicated that such was the case. A note which appeared in last week's REVIEW giving an extract from the half-yearly report of the North Metropolitan Tramway Company, coupled with the chairman's speech, which may be seen in our City columns, also seem to prove conclusively that the working has completely vindicated the assertions of those who have so steadfastly advocated the claims of electricity as an economical substitute for animal power. Therefore, according to what has been stated so far, the North Metropolitan Company in reality has at Barking a complete electrical equipment at about the same price per car mile as it costs on other sections of its lines to horse them alone. Naturally this is to the company and its shareholders a source of much gratification, and one can well understand the question asked at the meeting as to whether the chairman could guarantee that the working cost would be kept down to the 4½d. per car mile now exacted by the Electric Traction Company. On this simple matter is hinged the whole future of the operations, now apparently so favourable, and of the pending large extensions ; and we consider that the present moment is opportune for making a few comments upon what has hitherto been accomplished and what must eventually take place.

Statistics are said to prove anything, and, as previously mentioned, the data, so far as it is available, indicates prosperity ; but has every item which can make or mar electric traction been sufficiently taken into account? It must not be overlooked that the figures are the result of a six months' experience only, and what may be true for the first half-year may be completely upset in the next.

We have heard that accumulators such as are employed at Barking have been, in some instances, guaranteed by the manufacturers for 250 discharges only, if the positive plates are to remain intact, and to something like ten times that number for the negatives. Say that a car during an ordinary working day requires two charges ; this means that 125 days is the maximum time guaranteed for the lasting properties of the battery, of course assuming that no spare sets of cells are at hand : if each car has two sets they require charging but once a day, but then twice the capital must be expended in plant. However, let us extend the time of the accumulators to six months, and what will then happen ? In all probability the positive plates will require renewal all round and this will entail a heavy cost, enough it may be to more than counterbalance the profits accruing from the preliminary stage of the running.

We know the cost of electric motors, steam engines, fuel, &c., indeed, every item entering into the calculations of tramcar propulsion, can be accurately estimated except one, and upon this depends entirely the future of the Barking electric line. We do not know precisely what to allow for maintenance of the batteries. It is said that their prime cost has recently been raised as well as the price for renewals, and this policy is, we consider, akin to that of killing the goose with the golden eggs. As electric locomotion must eventually come to the fore, it should be assisted rather than retarded in its difficult path, and this can best be effected by granting such easy terms now as will be available when the monopoly in secondary batteries no longer exists. As it is not likely that tramway companies will work their lines on any other plan than sub-letting them to electrical contractors, we do not hesitate to say that it is in the interests of storage battery manufacturers to dispose of them, for the time being, at a reasonable profit, and afterwards to maintain the apparatus at a fixed sum per car mile.

One maker has already offered to do this for one penny ; surely the suppliers of the Barking line apparatus have sufficient faith in their wares to do the same, for if they cannot see their way to this the result

we have foreshadowed must assuredly be brought about. The success or failure of electric cars carrying their own motive power depends solely upon the cost of accumulator maintenance.

Medical Electricity.

IN the *Nursing Record* Dr. Arthur Harries and Mr. H. Newman Lawrence are writing on "Practical Lessons in Electro-therapeutics." Naturally those for whom this periodical is published will derive benefit from such practical instructors, but we sincerely wish that the Institute of Medical Electricity could see its way to publicly expose the pretensions of certain electropathic establishments. The well-known captain of an equally well-known cable ship writes to us this week :—"The enclosed cutting from a newspaper, which I have for many years considered respectable, beats all." We fear our respected contributor must have been away on a cable laying or repairing expedition at the time when comments upon such matters occupied a portion of our space. Such advertisements as those of which complaint is made have been going on for many months and are likely to continue to all eternity ; but is it not a lucky thing that there are but two establishments in the world where that "entity," the British public, in its dealings with them, so clearly shows how much better suited it is to come under the title of "nonentity ?"

Electric Light Cable Testing.

IT is very questionable whether the tests for insulation resistance in lighting mains, as they are ordinarily made, are of much value. An electric cable to carry a current of high potential is laid, let us say, in a subway or conduits, and after completion it is subject to certain tests, which show that the insulation resistance comes out at a very high figure ; on the strength of this figure of merit the line is passed, and pronounced exceptionally good. So soon, however, as the current at a pressure of, possibly, 2,000 volts, is sent along that circuit, trouble begins, and faults occur with unwelcome frequency. The cable is repaired and re-tested, and again all is believed to be right ; but no, the same kind of difficulties as before arise on working the circuit. Why is this ? Simply because the tests were made under misleading conditions, wherein all is in favour of the cable, and from which every danger of breaking down the insulation is carefully eliminated. The voltage of the battery employed in outdoor practical work seldom exceeds 200 volts, and is generally much under. The effect of such a current on the insulation of a lead designed to deal with 2,000 volts should be about as harmless as the fire from an ancient culverin on the side of the latest ironclad ship. Nothing but some palpable fault would be found, particularly as the battery would never be left on for more than a few seconds at a time during the perfunctory set of tests commonly made on electric light cables. We have always and repeatedly advocated the utmost care in every kind of electrical testing, and now that dangerous potentials are coming more and more into use, we would impress upon electrical engineers the necessity of subjecting all cables they may instal—when it is in their power to do so—to as rigid a set of tests as those to which submarine cables are submitted ; but let the strain put upon the cables intended for lighting purposes err on the side of severity, in order that slight faults, undiscernible by common practical methods of testing, may be removed, recollecting that by so doing expense of maintenance will be diminished, and the chance of fatal accidents from leakage be reduced to a minimum.

Danger from Gas in Subways.

THE leakage from gas mains in New York is known to reach some 10 per cent. of the whole supply, hence the difficulty from infiltration of the escaped gas into the subways and manholes in use for electrical purposes. The ignition of this gas has, up to this date, caused many upheavals along the sidewalks and some consternation among the inhabitants of the city. Thorough ventilation will overcome this danger. One of their papers remarks that the expense thereby to be incurred is hardly necessary considering how cheap and effectual the present mode is. An occasional explosion deals with the gas, while the only objection to the process consists in the possible removal of some few square yards of flagging, a very secondary matter compared with increased expenditure on ventilation. The gas company should be thankful for the safety valve thus provided for them.

A Hint for Madame Tussaud s.

THE Eden Museum of New York has added to its Chamber of Horrors a tableau representing an electrical execution, in which is realistically shown the executioner, the condemned person, and the complete apparatus for killing the criminal.

The Board of Electrical Control, New York.

MUCH opposition is expected to a Bill, lately introduced into the New York Legislature, to abolish and reconstitute the Board of Electrical Control. It is proposed to give the new commissioners powers similar to those of the Railway Commission. It will also be a *sine quâ non* that no commissioner or person employed under the Commission shall be elected who is receiving, or shall receive, emolument from any electric company. It shall be within the power of the Commission to investigate any electric accidents, to compel companies to furnish reports of all accidents, to prosecute the companies for any breach of regulations, to alter their mode of business, and after a hearing between the parties to regulate charges.

Dr. Werner Siemens on the Situation.

DR. WERNER SIEMENS'S opinion on the safety of electric lighting has been obtained by a correspondent of the New York *World*, who interviewed the doctor on the question now agitating the American Press — Can electric currents be made safe ? This opinion, formed, as it is, upon the varied experiences of vast and extended practical operations, should greatly tend to relieve the public mind from its state of inquietude and panic. Dr. Siemens considers that such accidents as have happened in New York will disappear when all wires are placed in well constructed conduits ; that gas and water pipes can never act as conductors of dangerous electric currents from the underground wires into dwelling houses. Insulated wires for street lamps should be concealed in the hollow stem, and where high tension currents are brought into a house every means should be taken to prevent possible contact with wires or lamps. Overhead wires should never have more than 500 volts pressure ; underground conductors with transformers no more than 2,000 volts.

The transformers and conductors should be, however, tested up to 5,000 volts. Insulated conductors protected with lead cover, asphalt, and sheet iron, have proved successful wherever used, and, after six years, are still apparently good ; their actual duration cannot as yet be ascertained. Dr. Siemens is evidently of one mind with us on the absolute necessity of taking every precaution in procuring the best and most trustworthy workmanship, and in providing against every dangerous contingency before sending the working current through an insulated cable.

The Threatened Corner in India-rubber.

RUMOURS come from Brazil to the effect that the Central Government is not inclined to confirm the monopoly granted to the Companhia Mercantil. Should this news prove to be correct, the agitation fomented by French merchants, against the monopoly, will cease to embarrass the Ministers of Commerce and for Foreign Affairs, who have been strenuously urged to interfere in the matter. The history of the affair, according to latest accounts seems to have been as follows :—A few years ago, a M. Viana formed a syndicate for the control of the India-rubber trade in France. The head office was at Havre. At first the operations of the syndicate succeeded, and by constant buying, the price of India-rubber was raised from five to fourteen francs a pound. In order to maintain this price it was necessary to keep on purchasing ; a limit to the operation of the firm was one day reached, and Viana became bankrupt. In consequence, however, of the benefits conferred on the inhabitants of Para, who, by the way, alone reaped any advantage from the operations of the syndicate, Viana received the title of Count. In no way discouraged by his non-success, Viana formed (last year, we believe) two companies for working the India-rubber trade, one under the name of Viana and Company, the other under the title of the Companhia Mercantil. The director and several of the shareholders formed part of the Provincial Council of Para, which under the former Government enjoyed the right of fixing the export duty on the products of the province. (Here in England we have heard rumours as to similar mutual arrangements having existed under the régime of our late municipal government.) The export duty has been, until now, twenty-two per cent., which was divided between the Province and the State. The new Brazilian Government decreed the suppression of the provincial assemblies, and transferred their prerogatives to the Governors of the Provinces. According to the *Temps*, the Governor of Para has just added to the twenty-two per cent. export duty already paid on rubber, an additional duty of twenty reis per kilogramme, which is to be paid in its entirety to the Companhia Mercantil.

Telegraph Convention between France and China.

THE Governments of the French Republic and of the Chinese Empire have lately concluded an agreement with the purpose of connecting the Tonquin lines with the Chinese, at three points on the frontier, by the following routes :—Between Dong-dang (Tonquin) and Tcheunnan-Konau (Chinese province of Konang-si), between Monkai (Tonquin) and Tonk-hing (Chinese province of Konang-Tong), and between Laokai (Tonquin) and Mongtze (Chinese province of Yunnan). The work upon the first of these lines will be commenced so soon as the convention is ratified, and upon the other lines within a period of 18 months. The convention is agreed to for a term of 15 years, and may be prolonged, should neither of the contracting parties withdraw, six months previous to its termination. This convention regulates all questions affecting the tariffs, and a special reservation is made should the case occur of any alterations being made in the respective positions of the Chinese Government and the "Great Northern" and "Eastern Extension" telegraph companies, so far as regards the terminal and transit charges upon communications exchanged with Europe or beyond.

Charging Batteries by Alternating Currents.

ON page 87 of our issue for January 24th there was mentioned an account of the progress which had been made in charging secondary batteries by means of redressed or rectified alternating currents, but the system of the American inventor named would probably be of little avail for the following reasons :—Alternating currents commutated to flow in one direction are not identical with the continuous current, for, although flowing in the same path, they vary periodically with the electromotive force of the alternator. Therefore, as the counter E.M.F. of the battery remains constant, we have within each period much variation of charging and discharging currents. A correspondent informs us that this difficulty has been surmounted by an arrangement described in a patent, No. 18,997, dated November 29th, 1889. In the method described, the inventor disposes his cells in such a way that the number inserted in the circuit varies periodically with the rise and fall in the alternations ; by this means the electromotive force of the alternator is nearly balanced at all periods by the counter E.M.F. of the battery. Thus he believes that the charging of accumulators may be expected to be successfully accomplished by means of alternating currents ; and we learn, with much gratification, that several firms are now about to make practical trials of the system.

Another Strike Ended.

YESTERDAY the Gas Strike came to an end, the leaders of the poor deluded workmen officially and formally declaring themselves completely beaten. Mr. Livesey will take on old hands as vacancies may arise on terms which were offered to them from the very first, and the victims of the two months' disastrous struggle may now ponder over the results of their foolhardiness with the certain knowledge that there are at this moment many families in South London wanting bread, and many once happy homes broken up. The lesson is a sharp one, and, for the beaten, hard to realise, but we believe that in the end it will have a most salutary effect if it only leads workmen to the belief that their self appointed champions do not possess an infallible power of settling disputes to their own satisfaction in the capital and labour question. Mr. Livesey deserves the thanks of all right-minded citizens for his unswerving devotion to his cause, for, with a man less determined, the consequences, with half London in darkness, might have been very serious. With thoughts of the Silvertown and South Metropolitan Gas Company's victories fresh in their minds, we hope that workmen will see the futility of commencing campaigns merely at the instigation of irresponsible outsiders who stand to win but not to lose. The loss has generally to be borne by those who strike.

THE COUNTER-ELECTROMOTIVE FORCE OF THE ARC.

By FRIEDRICH VOGEL.

IT may be permissible to develop as follows a view on the processes in the electric arc.

In a former paper ("*Messungen an electrischen Lichtbogen.*" *Centralblatt für Elektrotech.*, 1887, p. 189), I briefly indicated how a series of peculiarities and anomalies in the arc might be explained by electrolytic processes within it. More recent researches on the conduction of electricity in gases and kindred phenomena have raised what I then conjectured almost to a certainty.

According to the theory of A. Schuster (Proc. Royal Society, Vol. 37, p. 317, 1884), gases conduct electricity only when they have been resolved into atoms, whether by electric power, by heat, or by illumination. A series of valuable investigations, such as those of Arrhenius, Nahrwold, Narr, and others support the above theory, and it has recently received a complete confirmation from the admirable researches of Elster and Geitel (*Sitzungsber der Akad in Wien.* Math.-Natur. Klasse, Vol. 97, October, 1888), on the excitation of electricity by the contact of expanded gases with wires ignited by the current.

The production of the arc is generally begun by bringing the carbons into mutual contact. On the passage of the current the points of contact, which present a small section, become incandescent and warm the adjoining particles of the air. We have thus the condition for the transmission of electricity through air, as according to the observations of E. Becquerel, which have been confirmed by Blondlot (*Comptes Rendus*, Vol. 104, p. 283), air becomes conductive when heated to the temperature of redness. According to Schuster's view, we must regard the gases as, in part at least, dissociated.

The notion of the counter electromotive force of the arc was first introduced by Edlund, and has latterly been the subject of various investigations, especially by V. von Lang *Wiedemann's Annalen*, Vol. 26, p. 145, 1885), Nebel, Cross and Shephard, L. Arons, and others. We insert here a few measurements of L. Arons (*Wied. Annalen*, Vol. 30, p. 95). On the one hand, the true resistance of the arc was determined; and, on the other hand, the tension in the arc and the strength of the current. True resistance, 2·1 ohms; tension, 40·6 v.; strength of current, 3·4 amp.; apparent resistance, 11·8 ohms.

True resistance, 1·6 ohms; tension, 39·6 v.; strength of current, 4·1 amp.; apparent resistance, 9·7 ohms.

The apparent resistance is approximately six times as great as the true resistance—*i.e.*, there is other work performed in the arc in addition to Joule's thermic work. Lecher (*Vienna Akad Berichte*, Vol. 95, p. 992) contests the existence of a counter electromotive force, and inclines to the assumption of Wiedemann's discontinuous discharges, having found by experiment that the arc, after interruption of the current produces no deflection in the galvanometer, as is the case with electrolytes.

But it has not been found possible to demonstrate such partial discharges by means of a rotating mirror; secondly, a telephone introduced parallel to the arc gives no sound when the arc is burning quietly and a constant current is employed, such as that of accumulators. Lastly, Wild states (*Exner's Repertorium*, 1888, p. 224), that he has succeeded in obtaining a counter-current by rapidly connecting the electrodes with a galvanometer. The negative results of Lecher, always assuming their accuracy would not give any direct disproof of the existence of a counter-electromotive force. If the region of gases between the carbons has become cold during the displacement of the switch, &c., it acts as an insulator. In that case only the free portions of electricity existing on the electrodes can flow back, and these are, in any case, very trifling.

Schuster's views on the conduction of electricity in gases are calculated to explain the counter-electromotive force of the arc, if we consider the single stages of the process separately, and regard them as analogous to the decomposition in liquid electrolytes. We conceive the arc as in a stationary condition. In order to keep this gaseous region and the carbon terminals at a constant temperature, a certain electric work must have been expended, to which the true resistance of the arc corresponds. Secondly, the electrodes (in this particular case the carbons) must be gasified. Thirdly, the hydro-carbons and other gases produced, and the gases which pass into the arc from the surroundings, are dissociated. For both these processes an expenditure of work is required, and consequently an electromotive force which must act in addition to the power for Joule's heat, $J\,w$, when w is the true resistance of the arc. We will in particular consider the last-mentioned, the work of dissociation.

If, for an electrolyte, W signifies the quantity of heat liberated on the formation of a molecule of the compound, Q the quantity of electricity, by which the molecule is resolved into its constituents, the ions, a quantity of electric work must be conveyed to the electrolytes $c \,.\, \mathrm{Q} \,.\, \mathrm{E}$, and according to the theorem of the conservation of energy,

$$c \,.\, \mathrm{Q} \,.\, \mathrm{E} \,. = \mathrm{W}.$$

c is the electrical equivalent of a unit of heat. For a continuous resolution into ions, there must, independent of the electromotive force corresponding to the Joule thermic work, be an electrolytic force acting at the electrolyte:

$$\mathrm{E} = \frac{\mathrm{W}}{c \,.\, \mathrm{Q}}.$$

In the same manner in the dissociation of a gas an electrical expenditure of work is requisite and a minimum electromotive force for continued decomposition. If e denotes this electromotive force, q the quantity of electricity by which a molecule of the gas is resolved into atoms (ions) ϕ the atomic heat of combination of a molecule, then,

$$c \,.\, q \,.\, e = \phi.$$

and

$$e = \frac{\phi}{c \,.\, q}$$

The electromotive force, e, for the dissociation has the character of a counter electromotive force, even when it does not make itself perceptible by polarisation. It is the correlative of a performance of work.

The above considerations explain certain anomalies of the arc, such as that identical carbons, with an identical strength of current and an equal tension at the lamps, may give off different quantities of light according to external conditions, such as the proportion of moisture. The work expended in electrolysis, including dissociation, is various. If it is proved that gases conduct only as electrolytes by the resolution of the molecules into atoms the counter electromotive force of the arc supplies an important means of determining the heat of atomic combination.

According to Foeppl a perfect vacuum is a non-conductor. Monatomic mercury gas, which cannot be dissociated, is, according to Schuster's views, non-conductive, an inference which is confirmed by Elster and Geitel. The mercurial vapours, which are always present in a vacuum, obtained with the mercurial air-pump, do not interfere with the phenomena. Between mercurial electrodes no arc could be produced in a vacuum.

Carbon electrodes are not suited for the study of dissociation since they both absorb gases and are resolved into unknown carbon compounds. If we suppose pure metals burning in a vacuum the thermic work can be calculated which must be conveyed to the metal in the form of electric energy in order to heat a certain quantity to the point of ebullition. By weighing we find the quantity of the dissociated metallic vapour corresponding to the quantity of electricity, $q = i \,.\, t$, if i is the strength of the current and t the time. From the difference: total electric work, less

the Joule thermic work, $J^2 w t$, less the thermic work for heating up to the boiling point, we find the work of dissociation for the quantity of metal evaporated. If the experiments are repeated in simple gases with the same metals under different pressures, the work of dissociation for these can also be determined, which is equal to the work of forming the molecules.

Here we have merely indicated the approximate way for the experiments. The region for research is extensive, and a wide sphere is open for theory and practice.—*Repertorium der Physik*, von Dr. Exner. Vol. XXVI. Part I.

THE CONNECTION OF LIGHTNING RODS TO GAS AND WATER PIPES.

Reported by A. FISCHER, of Berlin.

(*Concluded from page* 131.)

Herr Kümmel, of Altona, a gasworks director, said: "I have for many years taken up the position that I would permit the junction of the lightning rods to the mains without burdensome conditions, and this, although I am at the head of a company which, as far as the rights of property are concerned, will always be more cautious than the municipal waterworks. I still hold the same view, and I see no reason to depart from it. All that I have experienced, and all that I have observed in other cities, confirms me in my convictions. They have in Cologne several hundred telephones, and it is my firm conviction that every telephone is connected either with the gas or the water pipes. I do not believe that the procedure in Cologne is different from that which prevails with us. In Hamburg there are 7,000 to 8,000 telephones, and they are, without exception, connected. No one has asked our consent; it has simply been done. As it is in Berlin it has also been done in other great cities, and we cannot prohibit it; we have no right to intrude into private houses and to hinder what could not be hindered without very tedious and very dubious legal proceedings.

"The Report of the Commission takes the position that everything brought forward by the electricians is scientific hypothesis not statistically proved. The electricians say, in turn, that all our scruples are just as little proved by statistics. In this respect both sides are on an equality. On this account we cannot lay a very great weight upon statistics, which cannot do us very great service. We must further remember that we are living in an electrical age. Electricians are at present the people whose words carry more weight than those of other people, and as reasonable men we must adapt ourselves to this state of affairs. As we see that all the eminent electricians of Germany—I believe without a single exception—like the Electrotechnical Association, hold that a connection of the lightning rods to the gas and water pipes is necessary, because the introduction of such conductive masses distinctly increases the danger for houses, we have nothing to oppose to this conviction. And scientific authorities of the highest rank declare to the public at large and to the magistrates who have to watch over the public welfare, and with whom we have to arrange, that such conductive masses occasion a danger to the inhabitants of the houses, the Government, in my opinion, can do no other than act upon the advice of those leading scientific authorities. In a case of doubt it will always do what is serviceable to the great bulk of the population, and it will care little whether possessors of works oppose the junction or not.

"If we take into account these preliminary considerations, our best, most judicious, and most practical policy will be to declare that we do not admit the necessity of the connection, we consider the danger non-existent, but we are unable to maintain and to prove that the connection will occasion us any danger. All these are undemonstrated opinions. We do not absolutely refuse the connection, but we say that though the connection appears to us unnecessary, we will permit it, but only under certain conditions. Prudence bids us if we cannot avoid an evil, to reduce it to a minimum. The evil will be smaller if we secure ourselves the right to object to imperfect lightning conductors. If the municipalities accept our proposals, the present state of affairs will be altered for the better. The present state of things means that a great number of conductors are connected to the pipes without our knowledge, and, if we know it, we have no power of prevention. I have found these conditions, which have been in existence in our midst for 12 years, to have answered very well. The magistracy has never scrupled to give its signature to the conditions which we put forward, and which are approximately identical with the proposals of the Commission. The lightning conductors are under inspection, and, though we have very many connections, we have sustained no damage. The only injury which has occurred was in a pipe not connected with lightning rods. In the interest of the works, I consider the acceptance of the proposals desirable. I think the opinion of the electricians and the technicists that the connection is absolutely necessary to be exaggerated, but at the joint conference held in Berlin, this view was strongly emphasised and it is not easy to contend against such authorities. Prudence compels me to recommend the proposals of the Commission."

Herr Diehl, of Munich, said: "There lies before us only one proposal, the proposal of the Commission, I had expected that Hegener would have made a counter proposal, but as that has not taken place, I venture to submit as a counter proposal that of the minority. This proposal, as drawn up by Dr. Schilling, runs:

"'The Commission declares that the connection of the lightning rods to the gas and water pipes can neither be recognised as necessary, nor can it in the interest of the gas and waterworks be universally admitted on practical grounds."

"I will somewhat moderate this motion by saying instead of 'admitted,' 'recommended.' If we have to give a definite answer to the question, whether we desire the connection or not, it is necessary to express this in the proposed motion. I request, therefore, your adhesion to my proposal, or in other words, that of the minority of the Commission."

Herr Söhren, said: "I should like to propose an intermediate motion between that of the minority (Diehl) and that of the majority, by adding to the Diehl motion the words: 'In cases of connection the conditions shall hold good which are proposed in the report of the majority. The motion would therefore run:

"'The association declares that the connection of the lightning rods to gas and water pipes can neither be recognised as necessary, nor can it, in the interest of gas or waterworks, be universally recommended on practical grounds. In case of connection, the conditions must hold good which are proposed in the report of the Commission.'

"I believe that justice will be done to both sides."

Herr Fischer said: "On H. Diehl's motion I should wish to remark that, according to the Commission, the Association should recommend nothing, either in one direction or the other, but simply declare the connection admissible or inadmissible. Reference has been made to the grounds in our printed report. The reasons do not belong to the scope of the Commission. The proposal of the Commission is very brief, and runs:—'The German Association of Gas and Water officials considers the connection of lightning conductors to gas and water pipes is admissible on certain suppositions and conditions.'

"The proposal of Dr. Schilling, which has been again brought forward with certain modifications, is that the connection is not generally admissible, but it may be sanctioned under certain conditions. I would, therefore, recommend that the proposal of the Commission be adhered to."

Herr Diehl then withdrew his motion in favour of the Söhren amendment.

After a few remark on points of order and formal modifications, the Söhren motion was drawn up as follows :—

"The Association is of opinion that a connection of lightning conductors to the gas and water pipes can neither be recognised as necessary, nor can it, in the interest of the gas and waterworks, be on practical grounds generally recommended. In case of connection the conditions should be observed which have been proposed by the Commission."

The President then put the Söhren motion to the vote, and declared it carried by a decided majority.

Herr Buhe then declared that the meeting by accepting the Söhren amendment had not passed, or intended to pass, a vote of want of confidence in the Commission. He begged the meeting to thank its Commission for its services, and to re-elect them as a mark of confidence.

The Commission was unanimously re-elected, its members abstaining from voting.

After re-election of the Lightning Commission Herr Fischer begged all colleagues present to report particulars of strokes of lightning to him or to some other member of the Commission in order to collect materials for the much-needed elucidation of this question.—*Elektrotechnische Zeitschrift.*

THE VAGARIES OF THE ELECTRICIANS.

THE vagaries of the electric light, says *The Gas World*, are so pronounced that the exhibition of the same undesirable qualities by its professors does not strike the observer as a thing surprising. We are accustomed to hear so many contradictory opinions expressed by the electricians that one more or less does not affect the general result—they are all taken by sensible people *cum grano salis*. We would not for a moment suggest that the many eminent men who have associated themselves with electric science wilfully endeavour to mislead the public: rather would we say that it is a case of the blind leading the blind. In this country we have a body of consulting electrical engineers whose names are honoured and respected throughout the length and breadth of the land—they are recognised as men who have attained the highest scientific distinction—but so far as the commercial side of their particular science is concerned they are but as babes. The operations of the practical workers in the realms of electricity have up to now been upon so limited a scale, comparatively speaking, that consulting engineers have not yet had placed at their disposed the data necessary to a uniformity of opinion. They can ascertain the price of a dynamo, the price of a lamp, and the price of a yard of copper wire; but there is very little to guide them to a proper estimate of what these three are capable of when coupled up, or how long they will last. The multiplication of "systems" is another complicating element. The consulting engineer may have some reliable data concerning a continuous current low pressure installation; but then his note book fails him when he wants to compare this with any other kind of installation. The truth is the consulting engineers are groping in the dark, and they have not the courage to confess it. Data is what they require, and, judging from the slow progress the Deptford scheme is making, practical workers are not in a hurry to supply their wants.

We have before us a recent example of what we have indicated above. For an electric light works to supply 10,000 16-candle-power lamps in St. Pancras, Prof. H. Robinson, M.Inst.C.E., estimates the cost at £49,731; for an installation of the same size in Brighton, Mr. Shoolbred's estimate is £30,000—practically a difference of £20,000. The systems are different and the localities are different; but each engineer thinks his system the best, and the difference of locality cannot amount to much, seeing that neither estimate includes the cost of a site. Of Mr. Shoolbred's report to the Brighton Council we have little to say, beyond congratulating that gentleman on the bold manner in which he solves the problem which has been puzzling the heads of scientists ever since electricity became known. He says: "It may here be mentioned that the words 'current' and the 'flow' thereof, still popularly used in speaking of electrical matters, are not intended to mean any actual translation of matter. Those words imply, more precisely, that the molecules forming the conducting wires are thrown, by the exciting magnetism of the dynamo, into a temporary and unstable condition of disturbance, and that this artificial condition is communicated from one molecule to its neighbour, and so throughout the length of the conductor." We cannot say that Mr. Shoolbred's definition is incorrect; we can only remind him that it is not yet generally recognised.

Prof. Robinson's report to the St. Pancras Vestry, an abstract of which appeared in our last issue (pp. 100, 101), calls for more detailed notice, inasmuch as, if hurriedly read, it may lead to erroneous conclusions. Prof. Robinson deals with both big and little figures. The big ones are comparatively plain, but the little ones must be studied to be understood. Briefly stated, the scheme which he has recommended to the St. Pancras Vestry, and which the vestry has adopted, is this: A central station to produce current for 10,000 16-candle incandescent lamps; neighbourhood of central station to be supplied direct at low pressure; outlying districts to be supplied from five transformer stations worked from the central station by continuous high-pressure current; transformer stations to be also storage stations (with about two hours supply in store!). The cost of erecting the central station and the transformer stations (with the necessary generating plant and storage batteries, and six miles of mains capable of supplying 25,000 lamps) he estimates at £49,731. This does not include the cost of a site for the central station, the vestry, we believe, having vacant land whereon it can be erected. These works he estimates equal to produce 600,000 watts—530,000 to the incandescent lamps, 20,000 to 40 arc lamps to be used for street lighting, and 100,000 watts of leakage—introducing a point upon which data is much required.

The annual cost of running the installation next engages Prof. Robinson's attention. The current supplied to the arc lamps in the streets he charges at 3½d. per unit, and the total cost per lamp per annum (including lamplighter, which is evidently a misnomer) he places at £38 11s. 4d.—£1,542 13s. 4d. for the forty lamps. The 200 gas lamps which the 40 arcs will displace cost only £560 per annum, but then Prof. Robinson triumphantly exclaims that the increased cost will result in an increase of 1,300 per cent. in light. If those who put forward this statement could only realise what it means they would abstain from their folly. But at present we are concerned with Prof. Robinson's figures, not his fancies. As we have seen, he puts the cost of supplying an arc lamp at £38 11s. 4d. per annum, but to this we have to add the cost of the lamps themselves. "The prime cost of the 40 arc lights, if erected in the cheapest possible manner, would be," says the Prof., "£1,000." No provision for renewals, for interest, or for redemption of capital appears to be made. Five per cent. would be a very low estimate to cover the omissions. Add five per cent. to £38 11s. 4d., and we get £40 9s. 10d. as the annual cost of an arc lamp—£1,620 for 40 arc lamps, against £560 for 200 gas lamps! If this is the best St. Pancras can do so much the worse for St. Pancras. In most towns in the United States, where gas is so dear, the electric light companies would be ashamed to charge such a price as this.

It is where Professor Robinson deals with the cost of producing the electric current that his report becomes most misleading. For 10,000 lamps he estimates an annual consumption of 800,000 units, and the cost of producing this he puts at 2·80d. per unit. To this, however, he adds 0·75d. for sinking fund (does this include interest?)—making the cost 3·55 per unit. But if this

be correct, it is astonishing that we have not heard of any dividend being declared by those companies who are charging 8d. per unit. To talk about 3½d per unit when 7d. or 8d. is the usual price may be an alluring bait to the St. Pancras householder at the first glance, but let us see how matters would stand with him were he to get the electric light at Professor Robinson's cost price. For 1,000 hours electric light: 60 units at 3½d. = 17s. 6d. + 3s. 9d. for a lamp = 21s. 3d. For 1,000 hours gas lighting: 5,000 cubic feet of gas at 2s. 6d. per thousand = 12s. 6d. + 1d. for burner, 12s. 7d. That is to say, taking Professor Robinson's figures at their best and the figures for gas at their worst, the price of electric lighting would exceed that of gas lighting by close upon 70 per cent. in Brighton, where the Corporation proposes to charge 6d. per unit, the difference in cost between electric lighting and gas lighting will be about the same. It is to be hoped that the householders of St. Pancras and of Brighton will be made aware of these simple facts before it is too late.

IRISH'S IMPROVED MEANS FOR OPERATING DEVICES ELECTRICALLY, AS APPLIED TO CUT-OUTS, "SHUNT-OUTS," AND SAFETY DEVICES.

[A COMMUNICATION.]

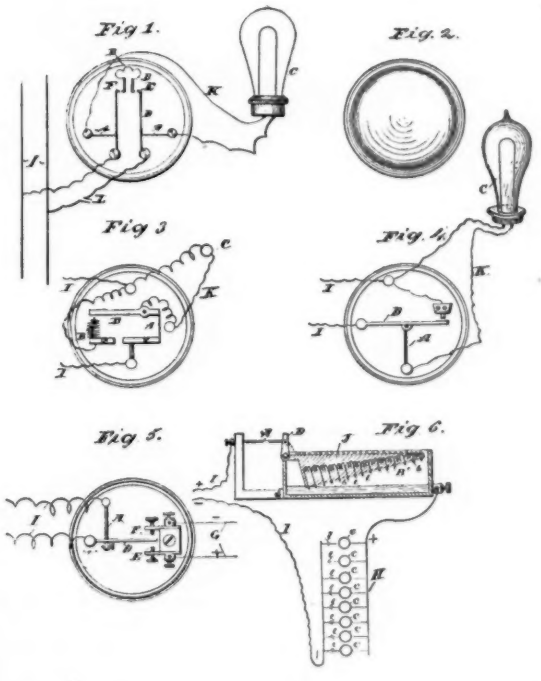
As a reliable automatic cut-out is a problem with all practical electricians, a description of some of these may interest many of your readers. In most instances these "shunt-outs" are self-restoring or permanently acting, and do not break the circuit, but shunts therefrom any excess of current, while permitting the lamps or other devices in circuit to continue in operation under all variations of the current above the normal.

One of its principal objects is the protection of incandescent lamps, but it is by no means limited thereto, as it may be employed in a number of ways in protecting circuits and other devices than lamps, where a magnetic or fusible cut-out could not; although, in every instance, it can replace these cut-outs without increased cost or complexity. It acts with a motor, fig. 18, to protect the armature, with a dynamo to protect it from short-circuits and sudden changes of load, with testing apparatus to protect same from accidental excess of current, with plating machines to regulate the current or cause an alarm to be sounded whenever the current rises or falls above or below the normal. As a potential indicator or alarm, fig. 5, it performs one of the most important services outside the generator; as an automatic cut-off for accumulators, fig. 17, there is nothing to equal it for simplicity, reliability, durability, and low cost; as an automatic resistance balance, fig. 6, for the protection of lamps, &c., it would be difficult to imagine anything more effective or simple; as an automatic ground cut-out, fig. 15, it leaves little, if any, room for improvement; as an alternating device or pole changer, fig. 19, it serves a very useful purpose; as a "shunt-out" for lamps, figs. 20, 21, it satisfies every possible requirement; as a controller and feeder for arc lamps, it far surpasses every other means; as an automatic regulator of dynamos and motor brushes, it is the essence of a perfect regulator. In fact, there can be no electric circuit where this device, in some form or another, cannot be advantageously employed. At present we have to deal simply with the "shunt-offs" and cut-outs. Any of the "shunt-out" devices can be set for or adjusted to any current within its carrying capacity. It acts simply and with certainty, and there are no delicate or complicated parts in its make-up. Any number of these shunt-outs, &c., may be arranged together in one box for the convenience of central stations, where they should be included in every circuit. The devices offer little or no resistance, and acts and reacts, affording at all times perfect protection to lamps, &c., for years without attention. It may be enclosed in any of the lamp sockets, rosettes, or flanges, and may be readjusted for any current within reason. It enables incandescent lamps to be run on arc circuits and lamps of different voltage, and different illuminating powers, to be run on the same circuit. It not only increases the efficiency of a system enormously, but it very considerably reduces the cost of maintenance by protecting the lamps or other devices and circuits, without being itself impaired.

These shunt-outs are applications of the law of shunted currents, as well as the application of the law of the expansion of conductors when traversed by an electric current; and it has been said of these devices that in design they are simplicity simplified, and that in use they are economic economy.

As illustrated (figs. 20, 21), this device in circuit with incandescent lamps, protects them by shunting off any excess of current, while permitting the lamps to glow instead of breaking the current, extinguishing the lamps, and thereby causing inconvenience, annoyance, and delay, as when the same duty is performed by other cut-outs.

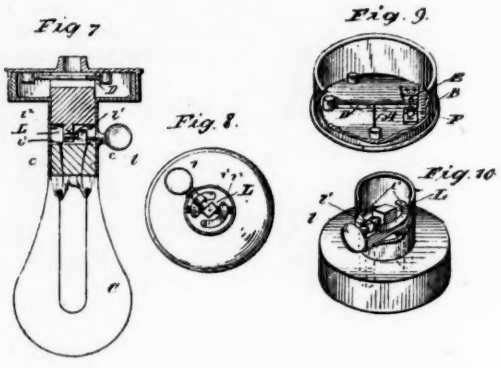
Fig. 1 represents a shunt-out adapted to control the passage of a current to one or more lamps or other devices. A and A′ are in all cases expansible metal strips or wires; D, D′, vibrating springs, stationary at one end and free at the other, so as to vibrate; in this instance they vibrate outside the contact points, E, F, which are terminals of a resistance shunt, B. The

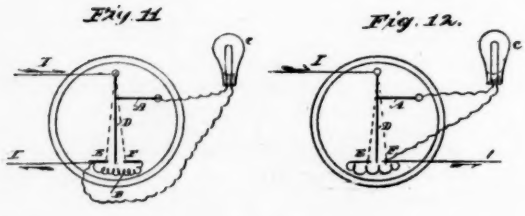


springs, D, are set with a tension which would bring them together, but the wires, A and A′, are tightened, so as to draw the springs apart; a normal current entering by the stationary end of the arm, D, passes through A, and lamp, C, to A′, and out by the other fixed end of D′. On the current increasing above the normal, the wires, A and A′, will expand, and allow the free ends of the vibrating springs, D and D′, to come in contact with the adjustable terminals of the shunt resistance, B, when the current will divide, one portion going to the lamp and the other portion through the resistance. On the current again falling to the normal the strips, A and A′, will immediately contract and lift the arms, D and D′, out of contact with the terminals of the resistance shunt, thereby opening that circuit and allowing all the current again to pass through the lamp or lamps, C. Fig. 2 represents this shunt-out complete with cover.

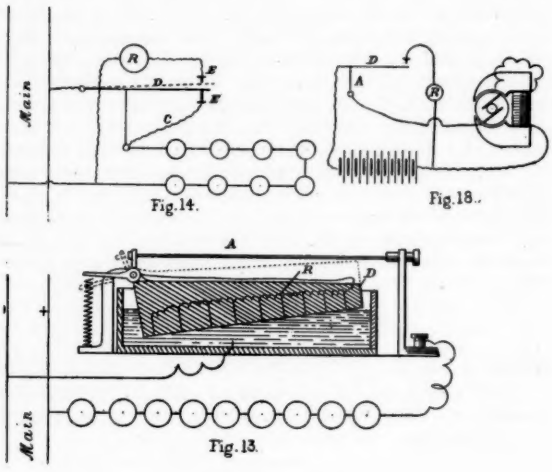
Figs. 3 and 4 have each but one expanding strip, A, and one vibrating arm, D. A normal current, entering

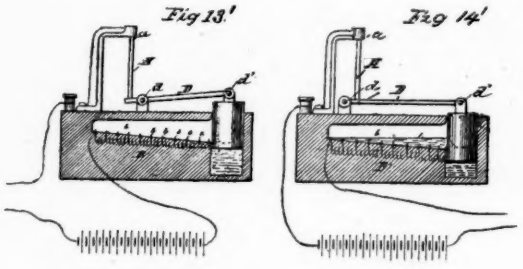
fig. 4 at I, passes along a portion of D through the expanding strip A, lamp C, and out by I'. On the current increasing D will rise proportionately by reason of the elongation of A, and when the current is such as would endanger the lamps the free end of D will make contact with E, and shunt from the lamps a portion of the current. As the current falls again to the normal A will contract and cut-out or open the shunt circuit. In figs. 11 and 12 the arms D, on open circuit, will rest against the contact F. In the former figure the current, on entering, is divided between the resistance B and lamp C, but the strip, A, which rapidly expands, opens the resistance circuit, so that after the first impulse the whole of the normal current passes through the lamps, the arm, D, taking an intermediate position between the contacts, E, F. When the current increases so as to endanger the lamps, A will expand until D comes in contact with E and closes the shunt circuit. In fig. 12, when A expands abnormally with an overload, the current will divide between the resistance B and the lamps, while a normal current will expand the strip, A, sufficient only to allow D to take up an intermediate position between the contacts, E, F. Fig 7 represents a

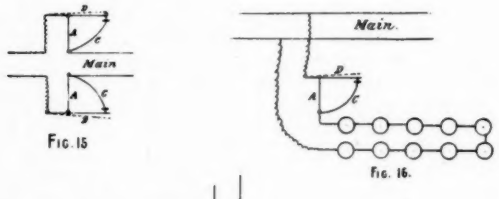


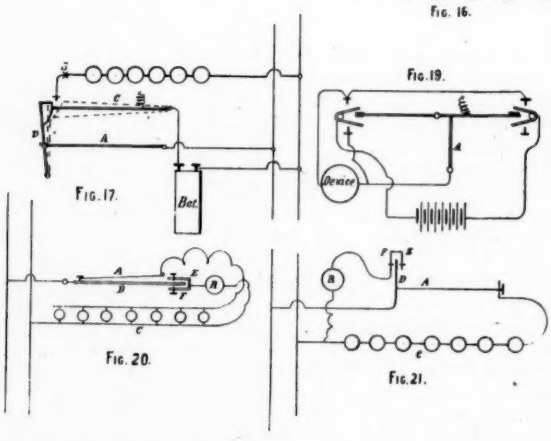


shunt-off in combination with lamp-key and socket. Fig. 9 represents the shunt-out contained within the socket, and fig. 8 and 9 are details of key. Fig. 5 represents a potential alarm, in which a normal current maintains the arm, D, intermediate between and out of contact with the screws, E, F, on any increase or decrease of the current above or below the normal, the wires, A, will expand or contract accordingly, and the arm, D, will immediately make contact with the screw, E or F, which are in connection with the generating station through suitable alarm and indicating apparatus. Fig. 6, is diagrammatic of a resistance balance in circuit with incandescent lamps. This device enables one or more lamps to be switched or turned on or off without affecting the others in circuit. In the fig. J, respresents a series of resistance coils, supported on a frame pivoted at D, and resting within a narrow tank containing mercury, into which the loops of all the resistance wires are immersed when the circuit is open. It will be seen that the greater the current passing through, A, the greater will be its expansion and the greater the number of coils cut out by the mercury. The coils are represented as being equal in number and resistance to the lamps in the circuit, so that, for instance, if one lamp is switched in circuit, the wires, A, will expand only sufficient to allow the two ends of the first resistance coil to dip into the mercury ; if five or more or less of the lamps are turned on the circuit, then five or more or less of the coils will be cut-out or put in circuit accordingly. When all the lamps are in circuit then all the resist-









ance coils will be cut-out by reason of the expansion of A, caused by the passage of the current necessary to supply the lamps. From this it will be seen that the device acts as an automatic balance between the current on the one side and the devices to be operated on the other. The current entering by I passes through the expansible wires, A, along the top of J to distant end of the resistance, thence through the resistance, out by the mercury and tanks to lamps.

By reversing the position of A the expansion of the latter will cause the resistance of the circuit to be increased instead of decreased—fig. 13′ and 14′ will make the action of these devices clear—fig. 14, represents a resistance shunt-out in circuit with lamps; its action will be readily understood from the above description. Fig. 15 is a double ground cut-out which acts as others, except with an excessive current, when A will be fused and the circuit permanently opened. Fig. 16 represents the same fusible cut-out in circuit with lamps. Fig. 17 is a regulator cut-off for accumulation. The current entering from the generator passes by means of A to D and from the spring, D, along C to the secondary battery and out again to generator. A will continue to expand as the charging goes on and gradually allow the spring, C, which makes a rubbing contact with the projection or cam on D to rise. When the charging is complete, A will have expanded so as to allow C to spring up in contact with +, thereby breaking the charging and opening, if desired, the circuit which the cells are intended to supply. A switch, as S, should be included in the local circuit.

Fig. 18 shows an armature protector, from which it will be seen that with a normal current A will not expand so as to enable D to come in contact with E, but that with an excess of current the expansion of A will be greater, and D will spring in contact with E and shunt the excess of current through R. On the current falling, A will again contract and open the shunt circuit. Fig. 19 is an alternator or pole changer, the action of which will be understood.

Mr. Irish has successfully applied the same principle to the operation of a variety of other electrical devices of quite a different character, which will be discussed later.

INTERNATIONAL ELECTRICAL COMPANY.

Supply of Electric Current from the Vienna Central Station.

(FROM A CORRESPONDENT.)

THE International Electrical Company has entered into an agreement with the Municipality of Vienna in virtue of which it covenants to supply electricity for the purpose of lighting to all occupiers in those streets along which a main cable has been laid, in as far as the capacity of the central station can be extended. It is bound to supply electricity from 4 p.m. to 1 a.m. unless prevented by force.

The connection of the leads in the streets as far as the meters situate within the houses, as well as all repairs, are exclusively undertaken by the company or its appointed contractors at the request and on the account of the consumer. The company guarantee the substantial and proper construction of these fittings for two years from the date of completion.

In installations in houses furnished by others the company is willing to supply the current, but has the right of testing the complete installation before connection, especially as to the safety, the sizes and the insulation of the leads, and the proper action of the lamps. For such examination the company is entitled to a fixed charge of 15 florins, with additional dues according to the number of lamps, varying from half florin for each glow lamp if the number does not exceed 50, to ¼ florin if it is above 100. For these dues the company undertakes the connection of the installation to their main street conductors. If an installation is not properly executed the company may refuse connection. There is no fee payable on an exchange of lamps.

If no special agreement has been made between the consumer and the company as regards payment, the current will be measured by electric meters and for this purpose a meter will be supplied to the consumer on hire at the following scale :—

For ten 16-candle glow lamps not exceeding ten florins.

For	25	...	...	16	florins.
„	50	...	...	20	„
„	100	...	...	25	„

The cost of maintaining and repairing the meters and of exchanging them if unserviceable is born by the company if the damage is not the fault of the consumer.

The payment for the electricity furnished will be made on the basis of a fixed charge of half a florin per month for each glow lamp + the current actually consumed. The price for the electricity consumed is founded on the quantity of electrical work which a 16-candle glow lamp requires for one hour. The price for this unit is $\frac{3}{100}$ths of a florin.

The price at which electric current will be supplied for arc lights or for other than illuminating purposes is determined by special agreement. The payment for the meters and the fundamental charge for the lamps and for the hire of lamps is due quarterly, and that for the electricity consumed monthly.

The company is bound to supply electricity for lighting only if the consumer binds himself to take the current at the standard price for at least a year. If the consumer does not give notice in writing at least three months before the conclusion of the year he becomes liable for another year. The company has the right of revising the meters, leads and other fittings from time to time and of repairing them if needful. The company has also the right, if the consumer makes alterations in the fittings on his own account, or if he refuses the inspectors or officials of the company access to the leads, meters or lighted rooms, or if he does not abide by the prescribed terms of payment, to cut off the connection and cease the supply of the electric current.

DYNAMO-ELECTRIC MACHINES.

WITHOUT, writes M. A. Minet in *La Lumière Electrique*, attempting a thorough examination of the electrical machines tested by us since 1881, which would be beyond the scope of our present purpose, we shall offer a certain number of observations as regards various points which have seemed to us fit subjects for reproduction here.

Some of these have regard to the density of the current in the wire of the field magnets and of the armatures; others have reference to the calculating of the magnetic field and of the coefficient of merit. We shall likewise recount our experiences with reference to an operation of considerable duration. This article is prefaced by a comparative table of the machines the most universally employed at the present day, in which the reader will find calculations as to their weight in relation to effective work and of the motive power absorbed.

The constants contained in Table I. have reference to 18 different types. We observe that the mechanical yield is very much the same as regards all the machines, and next, that the weights of the material employed corresponding to the unit of effective H.P. vary between 27 and 103 kilos.

If the light machines are more satisfactory as regards the material employed, they possess no advantage over the heavy ones as regards higher returns, since the mechanical yield is very much alike with all types; moreover, they are more costly than the heavy machines per unit of electric energy engendered, that is to say, their price per unit of material varies in greater inverse ratio than their weights per unit of power.

To sum up, if they possess certain qualifications which render them suitable to certain cases, we must nevertheless give the preference to the heavy machines, or those of medium weight, whenever the operation is intended to be continuous, and of long duration, as in electrolysis, the formation of accumulators, &c.

TABLE I.—*Industrial Results furnished by Dynamo-electric Machines at the Exhibition of* 1889.

Name.	Types.	Numbers.	Speed.	Power at the terminals		Power absorbed in H.P.	Yield.	Total weight.	Weight corresponding to	
				in watts.	in H.P.				1 effective H.P.	1 absorbed H.P.
							per cent.	Kilos.	Kilos.	Kilos.
Gramme	Supér. (ring) ...	Light Station	750	33,000	44·6	50·7	88	2,200	50	45
			440	57,600	77·8	88·4	88	5,150	66	58
			310	108,000	146	164	89	10,600	72	64
Edison ...	Drum, 1885	4	1000	17,600	23·80	26·2	90	1,520	64	57·5
		5	900	26,400	35·50	39	90	2,670	75	67·5
		6	800	35,200	47·50	52·3	90	3,370	71	64
		7	650	49,500	67	74	90	5,675	84·5	76
		8	350	88,000	119	131	90	11,750	99	89
	Drum, 1889	N	1000	17,600	23·80	26·2	90	1,710	72	64·5
		O	900	26,400	35·50	39	90	2,265	64	57·5
		P	650	39,600	53·50	59	90	4,160	78	70
Thury	4 poles, drum	H A ...	475	33,000	44·50	50	90	2,000	45	40·5
		H B ...	475	44,000	59	65·5	90	2,500	42·4	38
		H C ...	375	60,000	81	90	90	3,000	37	33
		H D ...	350	80,000	108	120	90	4,500	41·7	37·5
		H D ...	250	60,000	81	90	90	4,500	55·5	50
		H E ...	185	100,000	135	150	92	6,000	44·5	41
C. Brown, of Oerlikon	Manchester	7... ...	600	13,000	17·5	20·5	85	1,800	102	87
		8... ...	550	19,500	26·4	30·5	87	2,700	102	89
		9... ...	500	26,000	35·1	40	88	3,600	103	91
		10... ...	400	39,000	52·5	60	88	5,400	103	91
		11... ...	350	52,000	70·1	78	90	7,000	100	90
		12... ...	300	65,000	88	97	90	8,500	96·5	87
R. Alioth, of Bâle ...	4 poles ...	S	670	13,200	17·80	21·60	82	1,430	66	54
		T	600	17,600	23·80	28·40	84	2,040	86	72
		U	520	26,400	35·60	42	85	2,800	78·5	67
		V	460	35,200	47·50	55	86	4,000	84	72
		W... ...	400	53,800	71	81	87	6,000	84·5	73·5
		X	350	70,400	95	106	90	8,500	89·5	80·5
Fabius Henrion ...	disc	6	730	17,800	23·70	28	85	1,560	66	56
		7	670	24,200	32·30	38	85	1,820	57	48·5
		8	550	37,000	49·20	58	87	3,250	66	57·4
		9	400	56,200	75	88	87	4,550	53·2	46
Crompton ...	Manchester	18/110 j ...	1150	18,840	25·40	30	84·50	900	35·50	30
		25/110 j ...	900	24,750	33·50	41·50	80·50	1,150	34	27·30
		13/110 j ...	800	31,351	42·10	52·50	80·50	1,500	35·60	28·80
		22/110 j ...	550	24,750	33·50	41	81·50	1,850	55	44·80
		40/110 j ...	950	41,800	56·50	70	80·550	1,850	32·60	26·30
		30/110 j ...	470	35,750	48·10	48	83	2,500	52	43·20
		50/110 j ...	700	53,900	73	90	81·50	2,500	34·20	28
		40/110 j ...	460	45,100	61	75	81·50	3,000	49·20	40·1
		60/110 j ...	675	66,000	89	110	81·50	3,000	33·70	27·5
Jaspar	Manchester	5	700	16,100	21·80	27	81	...	...	...
		6	600	21,000	28·40	36	79	...	...	...
	4 poles ...	4	875	10,000	13·50	19	71	...	...	...
		5	700	16,000	21·60	28	77	...	...	...
		6	600	20,000	27	35	77·50	...	...	...
Ganz	Supérieur ...	Δ_4... ...	500	22,000	29·70	32	92	2,100	71	65
		Δ_5... ...	375	44,000	59·50	63	93·6	4,400	74	69·5
		Δ_6... ...	300	99,000	135	145	94	...	...	...
Desroziers	Plateau, intensif.	T 11/160...	800	11,000	15	...	...	758	50	...
		T 16/110...	800	16,500	22·50	...	..	800	35·5	...
		T 27/110...	650	27,500	37·40	...	...	1,200	32	...
		T 38/110...	650	38,500	52·40	...	...	1,500	29	...
		T 55/110...	500	55,000	75	...	...	2,000	27	...
		T 96/110...	350	96,000	131	...	...	3,500	42	...
		T 144/110	300	144,000	193	...	...	7,500	39	...
		T 192/110	300	192,000	261	...	...	8,000	31	...
Breguet, Gramme ...	Manchester	K... ...	800	19,250	26	31	84	1,500	60	50
		L... ...	340	27,720	37·50	45	83	2,000	53	44
		M... ...	600	38,500	50	60	83·50	2,500	50	42
Sautter-Lemonnier ...	Manchester	N... ...	950	22,500	30·50	35	87	2,000	65·50	57
		H... ...	810	31,500	42·50	50	85	3,000	70	60
		O... ...	700	44,000	60	70	85·7	4,800	80	70
		T... ...	400	70,000	94·60	111·30	85	7,200	74	63
		V... ...	250	100,000	135	159	85	14,000	103	68
Rechniewski	Supérieur ...	12... ...	...	13,750	18·60	23	81	587	32	26
		15... ...	...	25,850	35·10	39	90	...	...	...
		17... ...	...	36,300	49·40	54	91·50	...	...	...
Thomson-Houston	Cont. current	E_1 ...	1250	15,000	20·20	...	...	1,090	50	...
		H_1 ...	1150	18,000	24·30	...	...	1,890	77·5	...
		H_1 ...	1150	24,000	32·40	...	...	1,830	57	...
		H_1 ...	1150	26,400	35·60	...	...	1,830	51·5	...
	Alterntg. current	A	1150	18,000	24·30	30	81	...	...	...
		B	1150	30,000	45	55	81	...	...	...
		C	1070	30,000	81	100	81	...	...	...
Pieper	...	...	900	11,000	...	19	...	1,000	...	...
		...	750	16,500	...	28	...	1,200	...	...
		...	650	27,500	...	43	...	2,000	...	...
		...	600	38,500	...	62	...	2,500	...	...
		...	425	50,000	...	80	...	3,500	...	...
Mondos...	...	...	1300	1,200	...	...	92	800	...	...
Gérard...	Redressed current	3 C ...	1600	2,800	3·78	4	94·5	160	42·5	40·3
		M ...	1500	3,300	4·46	5·5	81	350	78·5	63·5
		L ...	130	3,500	7·45	8·5	87	500	67·5	59
Roger	Supérieur ...	4	...	17,000	...	25	...	...	...	...
		5	...	26,000	...	38	...	...	...	...
		6	...	35,000	...	50	...	...	...	...

TABLE II.—*Density of the Current in the Convolutions of the Field Magnets and of the Armatures of some well-known Machines.*

Name of machine.	Type and numbers.	Field magnets.						Armatures.						Speed.	Electro-motive force.	Total electric energy in H.P.
		No. of pieces of wire per convolution.	Diameter of test pieces of wire.	Section of the convolution, s.	Intensity, i.	Density, $\delta = \frac{i}{s}$	Resistance, ρ	No. of pieces of wire per convolution.	Diameter of a piece of wire.	Section of a convolution, s.	Intensity, i.	Density. $\delta = \frac{i}{s}$	Resistance, r			
			mm.	mm. c.			ω		mm.				ω	Revs.	Volts.	
Gramme	(*a*) galvan.	2	3·4	18·2	50	2·75	0·057	2	3	14·20	50	3·50	0·040	1800	20	1·35
	A reacting	2	3·4	18·2	45	2·47	0·206	2	2·6	10·60	45	4·25	0·153	1200	65	3·91
	A workshop	1	3·4	9·1	20	2·20	0·610	2	1·8	5·1	20	3·90	0·410	1200	107	2·90
Siemens	D_0	1	6·5	33·16	70	2·12	0·347	2	4·3	29	70	2·41	0·157	1200	284	26·9
	D_1	1	6·5	33·16	54	1·64	0·310	2	4	19·2	54	2·85	0·160	1200	198	14·5
	D_2	1	5·5	19·60	34	1·73	0·294	2	2·5	9·8	34	3·42	0·270	1200	116	5·3
	D_6	1	3·5	9·60	24	2·50	0·845	2	2	6·3	24	3·81	0·444	1200	69	2·2
	D_5	1	3·5	9·60	20	2·08	0·365	2	1·8	5·1	20	3·82	0·284	1200	42	1·1
Edison	1889	2	2·5	9·8	17	1·73	3·50	60	2·1	207	600	2·90	0·002	670	56	45·5
Breguet	Manchester	1	2·6	5·3	8	1·51	13·10	8	5·0	127	350	2·75	0·006	644	114	54
Desroziers	à plateau	1	3·8	11·3	19	1·69	6·25	12	4·1	158	680	4·29	0·005	300	154	142

(*a.*) *Of the Current's Density.*—The term, the current's density, is applied to the intensity per unit of surface—the square millimètre. For a given machine the value of this quantity is not the same in the wires of the field magnets as in the armatures, as *vide* Table II.

The term convolution is more particularly applied to the junction of the wires whose combined lengths is traversed by the total current.

Thus in the Gramme ring, which revolves between two poles, in which the winding would be composed merely of a single wire, the armature convolutions are formed by the junction of two wires in parallel. We know, as a fact, that each moiety of the Gramme ring is traversed by a current in a contrary direction to that which traverses the other, and the intensity of which is the moiety of that of the entire current.

Speaking generally, let n represent the number of wires of similar diameter, and arranged in parallel, to constitute the convolutions. Each wire will be traversed by the current $\frac{I}{n}$, and the section of the convolutions will be n times greater than that of the wire.

Notice was taken in the case of each machine experimented with of the number and diameter of the wires which compose the convolutions.

As regards machines in which the field magnets and the armatures are grouped in series, the intensity of the total current is the same in both portions; nevertheless the section of the coil of the field magnets is greater than that of the armature wire, and, consequently, the density of the current which traverses it is less.

When the field magnets are excited in parallel the intensity of the current which traverses them barely represents $\frac{2}{100}$ or $\frac{3}{100}$ of the intensity of the armature current; then it is that the idea of the current's density becomes useful by enabling us to compare the quantities of electricity which circulates through the two portions of the machine.

The figures in Table II. have reference to Gramme and Siemens machines of diverse patterns and variety of winding, and to a single type of the Edison, Breguet and Desroziers machines.

The experiments with the Gramme and Siemens machines date from 1881-82. Experiments with the others were made in 1887-89, and the machines themselves date from this epoch.

The Desroziers machine presents the greatest density of current in the armature; this is to be ascribed to the peculiar disposition of its armature upon which the wires are arranged so as to pass radially between six pairs of magnets of alternate polarity.

The cooling of the armature of this machine is more easily effected than that of any other.

There is nothing to remark with reference to the current's density in the field magnets the values of which in the actual machines are close upon 1·5.

According to Table II. the density of the current in the armature of the Edison machine is 2·9. By varying the conditions of the experiment we may arrive at a greater degree of density.

(*To be continued.*)

FRENCH TELEPHONE COMMUNICATIONS.

THE Minister of Commerce has just signed a decree fixing the conditions by which it will be possible, either to unite a town furnished with an urban telephone line to localities in its immediate vicinity, or to unite in a group the urban lines serving localities in the same district having interests in common as regards industry and commerce.

The General Telephone Company had obtained, on the following conditions, permission to organise suburban lines around lines worked by it and to unite them together. In order to communicate with an urban line, the subscriber to the suburban line had to pay the amount of the subscription to this urban line, plus a supplementary rent of 600 francs; when the two lines were more than four kilometres distant from each other, he had to pay a sum of 100 francs per kilometre in addition. If the line which united the two lines were constructed in subterranean cables, this sum was increased 50 per cent. Subscriptions could not be taken for a less period than five years. This high rate was of a prohibitive character, and no suburban line around the urban lines worked by the company was formed.

On the lines laid down by the State and becoming the object of a parallel working, a different system has been applied. This system consists in uniting to an urban line, called the principal, all the small localities which surround them and are as it were appendants, then to unite these principal lines so as to form a telephonic group. Each inhabitant wishing to be joined on to a centre placed outside the group of which he forms a part must pay, in addition to the urban subscription, 10 francs per kilometre of single wire uniting the office of the appendant line to that of the principal line. In addition, all the subscribers of the principal or appendant lines may communicate in the interior of the group by the payment of an amount in deduction of which figures the sum already paid for uniting the appendant office to the principal office.

Since the taking over by the State of the working of the lines established by the General Telephone Company, applications have come in from all points of the suburbs of many towns, and specially from the city of Paris, with a view to obtaining suburban telephone communications on the conditions hitherto admitted on the State lines. It was, therefore, to satisfy these demands

that the Minister signed the following decree, which, while applying the anterior regulations of the State lines to the old lines of the General Telephone Company, establishes unity of legislation. The decree runs as follows :—

Article 1.—With a view of permitting the exchange of telephonic communications between subscribers to urban lines belonging to the same district, urban telephone lines may be constituted into telephonic groups. Telephonic groups are elementary or compound.

Article 2.—The elementary telephonic group is formed by the union of a principal line, and of one or several appendant lines joined to the principal line by one or several direct telephone lines established and maintained at the expense of the State.

Article 3.—The subscribers of appendant lines forming part of the same elementary telephonic group may obtain communication with all the subscribers of the group if they contract a supplementary subscription. The amount of this subscription is 10 francs per kilometre, or fraction of a kilometre, of single wire uniting the office of the appendant line by which the subscriber is served to the central office of the principal line.

Article 4.—A line can only be declared an appendant line if five subscribers of that line, at least, engage to contract the supplementary subscription.

Article 5.—The subscribers of the principal line may obtain communication gratuitously with the subscribers of all the appendant lines who have contracted the supplementary subscription.

Article 6.—The compound telephone group is formed by the union of elementary telephone groups, of which the principal lines are joined by one or several direct telephone lines established and maintained at the expense of the State.

Article 7.—The subscribers of different lines forming part of the same compound telephone group may obtain communication with all the subscribers of the group, provided they contract a supplementary subscription, the minimum amount of which is 150 francs per year. If the amount of subscription to one of the lines of the group be higher than that of the other lines, the sum includes besides the difference between the amounts of the two subscriptions.

Article 8.—The amount of the subscription fixed by Article 3 is taken in deduction of the amount of the subscription fixed by the foregoing article.

Article 9.—The supplementary subscribers to elementary or compound telephone groups are subject to the regulations laid down for the subscriptions to the urban lines by the decree of September 21st last, in so far as they are not contrary to the dispositions of the present decree, with the exception always of the dispositions relative to clubs and establishments open to the public contained in Articles 2 and 9 of the said decree.

Article 10.—The legal character of the appendant or principal line and of the elementary or compound telephone group is declared by a decree of the Council of State. This decree fixes the amount to be collected by the application of Article 7.

Article 11.—Up till the time when the lines of the City of Paris shall be entirely reconstituted the subscribers of the lines which shall be declared appendants to those of Paris cannot require the putting into communication of these appendant lines.

A DANGER TO THE ELECTROTECHNICAL INDUSTRY.

[FROM A CORRESPONDENT.]

THE bitter war, which has for a considerable time been raging in America, by the powerful representatives of the continuous current industry, ostensibly against currents of high tension, but essentially only against high tension alternating currents and alternating current transformers, and which has finally come to an open expression in New York, has now been transferred to Europe, where it is insiduously conducted in the columns of the daily press, and where it tends to the mystification and alarm of the lay public.

Hitherto differences of opinion as to the danger of electrical currents have been put forward in technical journals. In our opinion a contest on this subject is quite objectless, as in this direction no question exists. Every *honest* electrician will openly admit that any electric current of high tension is dangerous to the human organism. Hence it is the duty of the authorities, who watch over public safety, to see to it that such tensions are employed only in so far as they can be made unquestionably inaccessible. It is the duty of science and of the scientific press to point in a practical manner—disregarding all business considerations—to the means by which the danger of high tension currents may effectually be prevented in all cases where their use appears industrially advantageous. But no unprejudiced technicist or manufacturer will propose a sweeping condemnation, and demand that a useful method for the industrial application of electricity should be simply prohibited because under certain circumstances—*i.e.*, the neglect of due precaution—it may prove harmful. In like manner, no one thinks of forbidding the manufacture and distribution of gas because it has been the source of numerous calamities where proper care has not been taken. But when, under the mask and cloak of humanity, private business purposes are pushed forward by prominent representatives of our industry, we must protest.

It cannot be beneficial to science if strictly technical questions are distorted in the daily Press for the edification of the general public, and are used to render the inexpert reader hostile to certain rival firms, and favourable to others. Electrotechnics are directly compromised if such a policy is adopted by any firm whose members have been eminently active in the field of science, and have acquired a certain authority, since in such cases the respect felt for science and its representatives is abused for competitive purposes.

To these reflections the reader will be led by the following excerpt from a Vienna paper, on the source of which I submit the following communication :—

For some weeks the daily papers have been producing frightful notices, of American origin, on calamities occasioned by electric light installations. These stories are put forward in a certain systematic succession, leading to the suspicion that we have here objective action guided by a skilful hand. The morning issue of the *Presse* of January 23rd, contained a lengthy article concerning "Fatalities by Electricity." The paper in question appears in Vienna where the firm of Siemens and Halske are erecting electrical works on the continuous current system, and where they expect dangerous rivalry from the electrical works of the "International Electrical Company," which are being installed on the alternating-current transformer system. This company has just made public its conditions for a supply of current. In the evening edition of the *Presse* of the same date (January 23rd) there appears the following publication of the above named firm :—

"To the editor of the *Presse*, Vienna, January 21st.

"In its morning issue of to-day the *Presse* gives an article on 'Fatalities of Electricity,' containing statements calculated to deter the public from the introduction of the electric light. Since this light is now beginning to get a footing in Vienna, and the first results are to be seen in some streets, such as the Bauernmarkt, it may be suitable to append to your article (which contains in general a correct statement of facts) the following explanations which are to experts a matter of course, but which are necessary to prevent the public from drawing erroneous conclusions from your valuable communications.

"In New York the installations for the supply of electric light work principally with high tension alternating currents and with leads conveyed above ground. To your New York authority this circum-

stance may be so much a matter of course that he did not regard it as worth especial mention. But on the European continent, where high tension alternating currents are only exceptionally met with it is necessary for a right understanding of your esteemed article. The danger of electric leads, of which you speak, lies solely in the use of high tension currents and not in that of currents of such tension as are in use in the great cities of the Continent and in the Vienna central stations, 'Am Graben' and at 'Maria hilf.' It is not yet decided at what limit danger begins in currents of high tension. It may, probably, not commence below a tension of 600 volts. The tension of the currents supplied from the above-named central stations in Vienna, remains far below this lower limit of danger, and from the nature of the machines employed, it can never rise to the margin of danger. In electric currents, such as have been *hitherto* employed in Vienna, there is not the most remote approach to danger for human health and life. As already stated, this danger would occur only if currents of higher tension (says 1,000 volts) were employed. It must not pass unnoticed that currents of equally high tension differ in their effects according as they are continuous or alternating, and it is indisputable that the latter currents have a more dangerous action upon the human organism than continuous currents of the same tension.

As the central stations 'Am Graben' and at 'Maria hilf' work only with continuous currents there is no ground for fear as regards currents supplied from these stations.

"Respectfully,

"*Pro.* Siemens and Halske,

"Schwieger."

This short representation of affairs shows that there is offered to the readers of the *Presse* a drama drawn up with masterly skill. Is it not really ingenious how the limit of danger of electric tensions is suddenly raised from 200 volts (the universal practice hitherto) to 600 volts, in order to bring the "five-lead system" of the above firm within the limits of safety, though it is well known that continuous currents of 400 volts may kill, under certain circumstances, and have already killed human beings?

[Except our correspondent is mistaken in his dates, we have here Herr Schwieger writing, on January 21st, a letter in reference to an article which appears in the *Presse* on January 23rd!]

I have here given only a single, though a very prominent point among the numerous phenomena of that war which has originated in America, and is now being waged in Europe with American means. My object is to show into what regions the treatment of scientific questions in the department of electrotechnics has strayed.

In the interests of electrotechnics, I may assume that I am not alone in these views and impressions. It is plain that the art must by such a line of policy be discredited and seriously damaged.

Whilst writing these words I have just received the last issue (No. 9) of the *Electrotechnisher Anzeiger*, in which the present manner of discussing electrotechnical questions in the daily Press is characterised in very plain but perfectly appropriate language. I will here reproduce a few sentences from the article concerned, which perfectly agree with my own views:—

"The daily papers—so says Herr Ladislaus Fiedler, the author of the article—which have no technical member on their staff, often bring forward intelligence which is not exactly calculated to win public approval for electrotechnics. The most recent events in New York have given many journals occasion to relate such horrible stories that an outsider might tremble at approaching a central station, not alone at New York, but elsewhere, and might regard it simply as a place of execution. I have quite lately been obliged to expose the idiotic folly of a newspaper story, according to which a workman engaged upon the roof of a house in New York, having come in contact with a wire, was formally cut in two, so that the two halves of the body fell down and scattered a rain of sparks on all sides. We must remember that, though we live in the nineteenth century, human folly has not died out, and that the distrust of anything new which is rooted in the human character is still in existence."

These words should be laid to heart by all who, led astray by interested aims, play a dangerous game, sowing the seeds of suspicion among those masses who have only with great difficulty been brought to recognise the benefits of electrotechnical industry.

To prevent every misunderstanding I will once more emphatically repeat that it never enters my mind to represent the dangers of high-tension currents as non-existent. On the contrary, I have the conviction that the true and honourable friends of the alternating current transformer system would be much more benefited than its enemies if a clear light were thrown on the matter, and if strict care were taken that installations with high-tension currents were carried out only with a conscientious regard of those precautions which practically exclude the dangers involved. Certainly the electrotechnical industry altogether will be seriously damaged if the electric execution humbug, which in its birth-place is approaching its end—the end of an unsuccessful financial speculation, a fit counterpart to the electrical sugar swindle—is imported into Europe to injure the reputation of electrotechnics just on the eve of public recognition. Such conduct is certainly *a danger for the electrotechnical industry.*

REVIEWS.

Traité Elémentaire de L'Energie Electrique. By E. HOSPITALIER. Vol. I. Paris: G. Masson, 120, Boulevard St. Germain.

This work will be complete in 2 vols. The present one deals with "Definitions," "Principles," "General Laws," and "Applications to Measurement." The second vol. will deal with "Industrial Applications."

M. Hospitalier is so well known as an able writer that any work compiled by him deserves consideration. The author opens his preface with the not unusual apology that as there are now so many works on electrical science it may seem bold to bring out a new one. We are very much inclined to think that the constant publication of new works of this kind is being carried to rather an absurd extent, though, as long as there is a sale for the wares, writers will be found to come forward, and we cannot blame them for doing so. Much as we like M. Hospitalier's new production it can hardly be said to possess very many new features, though no doubt there is a good deal in it that is original, and what is not strictly original is dished up in a style peculiar to the writer.

The book is divided into 18 chapters, as follows:—Introduction—Quantités, grandeurs et unités physiques basées sur le système, C.G.S.; I. Notions générales de magnétisme; II. Notions générales d'electrostatique; III. Courant électrique—Systéme électromagnétique C.G.S.; IV. Resistances; V. Intensités—galvanométrie; VI. Potentiels — Electrométrie; VII. Générateurs d'énergie électrique théoriques; VIII. Quantitiés et capacités—Méthode balistique; IX. Phénomènes de contact — Electrochemie; X. Electrothermie; XI. Electrodynamique; XII. Compléments de magnétisme — Aimantation due aux courants; XIII. Induction électromagnétique; XIV. Self-induction; XV. Induction mutuelle; XVI. Courants alternatifs; XVII. Compléments de mesure; XVIII. Questions diverses. A great point in the author's book is the fact that it is written very closely up to date. The matter, moreover, has been most judiciously selected, and is most reliable, in fact the name of the writer is a sufficient guarantee that this would be the case. Altogether, although the production does not present any very novel features, we can heartily recommend it for the purpose for which it was written.

Turning Lathes: A Manual for Technical Schools and Apprentices. A Guide to Turnery, Screw-Cutting, Metal-Spinning, &c., Edited by JAMES LUKIN, B.A. Third Edition. Britannia Company, Britannia Works, Colchester.

In submitting this book to us, the publishers request that we will give a "favourable" notice of it: this is a somewhat unusual request to make when a book is sent for review, as it is usually understood that it should not be considered from any other point of view than an entirely unbiassed one. Fortunately, however, our opinion is distinctly a favourable one. Although the book is written with a view of advertising the Britannia Company's tools, it really is a work which is extremely useful, and we can quite believe the statement that it has practically been unanimously spoken well of.

Electric Light Installations and the Management of Accumulators. By Sir DAVID SALOMONS, Bart., M.A., Assoc.Inst.C.E. London: Whittaker & Co.

Sir David Salomon's work on the management of accumulators is well-known, and has already reached the fifth edition, comprising over 300 pages of subject matter; the first edition, which appeared some four years ago, being merely a small pamphlet of not more than one-tenth of the size of the present volume, Such is the progress made during this short period; but the author has expanded his subject, and, instead of confining himself to the original idea, has added to the "Management of Accumulators" so much other matter that this subject begins to take a back seat, and gives place to the broader consideration of "Electric Light Installations." The first part, comprising ninety pages, deals almost exclusively with descriptions of, and the use, and management of E.P.S. and Elwell-Parker accumulators; and this division has been but slightly advanced since the last edition appeared. Sir David admits that the named types of cells have chiefly been dealt with, "because at present they are almost universally used notwithstanding that many other types exist; and, though time may show some of the latter to be superior, that moment has not yet come." Does the author inform himself of the progress made on the Continent and in the United States with other types than those he favours? No mention of this is made in his book, and we should like to know the reasons for the omission. We are pleased to notice considerable improvement in style and description adopted by Sir David, and congratulate him accordingly. The expansion of various chapters of the second part, including instruments, testing, fire office rules, alternating currents, and estimates will be found more useful to the general reader and young mechanic than to professional electricians; and we have no hesitation in recommending this useful treatise to those for whom it is intended.

Physical Memoirs. Selected and translated from foreign sources under the direction of the Physical Society of London. Vol. I., Part 2. London: Taylor & Francis, Red Lion Court, Fleet Street.

This volume contains two articles, viz., "On the Conduction of Electricity in Gases," by Prof. W. Historf, and "Radiant Electrode Matter and the so-called Fourth State," by Dr. J. Puluj. The first of these translations was furnished by the late Dr. De la Rue. The matter occupies over 330 pages, and is well illustrated with figures in the text, and with plates.

The Ether Theory of 1839 *is the True Theory of the Leyden Jar, as established by Modern Electrical Discoveries.* Part I. By JAMES JOHNSTONE. James Gunwell, 19, George IV. Bridge, Edinburgh.

The ether theory referred to is one published by the author in 1839, and is the result of a discovery made in that year that electricity passed through glass. The author discusses Dr. Lodge's writings on the subject of electricity, and criticises them adversely, while, of course, he states that his own theory is the correct one; there will probably be differences of opinion as to this.

LEGAL.

International Cable Company, Limited.—The petition presented by A. S. Bolton for the winding up of this company was again before Mr. Justice Stirling, in the Chancery Division of the High Court of Justice, on Saturday.

Mr. HASTINGS, Q.C. (with him Mr. Grosvenor Woods), asked that the petition might stand over, with liberty to cross-examine the deponents upon their affidavits. He said the company was formed to lay a cable under a Portuguese concession, and the petitioner alleged that the concession had been forfeited. This was denied on behalf of the company, and, therefore, he wished to cross-examine the persons who so stated.

Mr. BUCKLEY, Q.C. (with Mr. J. Chester), on behalf of the company, objected to any adjournment, alleging that the petition was a demurrable one. The petitioner, when sued for his calls, by way of retaliation, presented the winding-up petition.

Mr. HASTINGS said the petitioner was a man of large means, and perfectly able to pay his calls.

His LORDSHIP said he would deal with the question of demurrer at once.

Mr. HASTINGS then read the petition, from which it appeared that the company was incorporated, with a capital of £1,000,000 in £10 shares to lay cables between the Azores, West India, Canada, the United States, and Great Britain; that within the last few months the concession from the Portuguese Government had lapsed, and that no renewal could ever be obtained. It was further alleged that moneys had been improperly paid to the promotors, that the directors had gone to allotment without sufficient shares being subscribed for, that the company had not commenced business within a year of its incorporation, and that, in fact, the substratum of the company had entirely gone. The learned counsel said there was a distinct allegation that the object of the company was the connection of Portugal with the Azores and the continent of America, which could only be done under a concession from the Portuguese Government, and that this concession was gone, and, therefore, upon the authorities there was an entire loss of the substratum of the company, which justified the petitioner in asking the court for a winding-up order. In support of this proposition he cited the cases of the Haven Gold Mining Company and the German Date Coffee Company.

Mr. BUCKLEY said the allegation that the company had not sufficient capital was not enough to obtain a winding-up order. No doubt the petitioner was disappointed in not having received orders for copper wire which we would have set off against his calls, but that was no reason for winding up a company which was carrying on the business for which it was incorporated. The petitioner was not supported by a single shareholder. He suggested that this was not a *bona fide* petition, but was presented with an ulterior purpose.

His LORDSHIP having expressed an opinion that the petition was not demurrable,

Mr. BUCKLEY said he would not press his objection further.

Mr. WARRINGTON said he appeared for shareholders representing £34,000 and he supported the petition.

Counsel for shareholders holding 1,100 shares and creditors to the amount of £700 said he was instructed to oppose the petition.

His LORDSHIP ordered the petition to stand over until after the cross-examination was completed.

Re J. Fyfe (in Bankruptcy).—The examination came on before Registrar Brougham yesterday.

In examination the bankrupt stated he had done his best to get statements of affairs ready, which would be filed on that day.

A short adjournment was then granted, the next examination to be on February 27th, at 11 o'clock.

The Telephone in Holland.—The Dutch Bell Telephone Company is about to extend in an important manner its interurban lines by establishing communications between Amsterdam and Haarlem, Amsterdam and Zaandam, Rotterdam and Dordrecht, &c., which will allow of towns having telegraphic communication extending their communications. The uniform rate will be 6d. for three minutes' conversation. Amsterdam, which on January 1st, 1888, had 1,368 subscribers, had on the following January 1st, only 1,490, which is a slow rate of progress.

NOTES.

Electric Lighting of Steamships.—Says the *Steamship*: All new passenger steamers are now being fitted with the electric light, and many old and new cargo steamers are similarly lighted. The light is also come into general use for working the cargo at night. Several leading shipbuilding firms have added an electrical department to their works.

Camberwell Lighting.—At a special meeting of the vestry assent was given to the application of the London Electric Supply Corporation to the Board of Trade for a provisional order for powers to carry out the electric lighting of the parish. Twenty-five members voted for and twenty-two against the motion.

Continental Lighting.—The Town of Hanover has just voted £75,000 for an electric lighting scheme. The order for a first installation of 15,000 lamps has been given to Messrs. Schuckert.

Electric Lighting in the City.—At a recent meeting of the Commissioners of Sewers, the Clerk read a letter from the Brush Electrical Engineering Company, asking that the western district of the City may be included in their contract with the Commissioners for electric lighting. The letter was referred to the Streets Committee. The Solicitor (Mr. Baylis), in answer to Mr. Williamson, said the draft contract for lighting another portion of the City was in the hands of the Brush solicitors.

Islington Lighting.—At a recent meeting of the vestry, after reading the report of the Electric Lighting Committee, it was resolved to serve objections on the various electric lighting companies to the orders proposed to be obtained by them, and, subject to this, further consideration of the matter was adjourned until the next meeting.

Lambeth and St. Luke's Lighting.—Notwithstanding the recommendation of its committee that the Vestry should give its assent to the application of the House-to-House Electric Light Supply Company for power to light the entire parish, the latter has decided to oppose all schemes by electric lighting companies. On the other hand, the St. Luke's Vestry has decided not to oppose the schemes promoted by the two electric lighting companies.

Weybridge Lighting.—At a recent meeting of the Vestry a report by Major Cardew, electric adviser to the Board of Trade, was read, which stated that the present overhead wiring was not in accordance with the Board's regulations for high-pressure service as regarded the insulating covering. Other breaches of regulations were also mentioned. To comply with these regulations—which would necessitate that the imperfectly insulated wires should be taken down and covered with India-rubber—would, it was stated on behalf of the contractors, involve, perhaps, £400 to £500. A member complained that the contractors were having lawyers' letters from all quarters threatening them with proceedings if they erected the poles, put wires on the poles, or interfered with trees. The wiring was proceeded with tentatively, simply to see if those threats would be carried out. The objectors afforded no pecuniary help towards having the thing done differently. After some discussion, it was decided to make arrangements for placing the conductors underground, as soon as the experimental lighting had been fairly tried.

Dundee Lighting and Harbour Trust.—A clause is to be inserted in the Dundee Electric Light Bill and order expressly excepting the right of the Harbour Trustees to carry out their own lighting.

Bolton Lighting.—At a private meeting of the Town Council, the question of electric lighting was further considered, and it was decided to take the sense of the tradespeople of the borough in the matter.

Mirfield Lighting.—The electric light is now being extensively used by manufacturers in the Mirfield district.

Electricity in Harbour Lighting.—The harbour of Bordeaux will shortly be lighted electrically.

Recent Interruptions and Repairs to Land Lines and Submarine Cables to January 25th, 1890:—

Cables.	Interrupted.	Repaired.
Trans-Atlantic Section of the Western Union Company's Systems	Sept. 11, 1889 ...	Jan. 2, 1890
Fauve (?) to Calais	Jan. 6, 1890 ...	still interrupted.
Para to Maranham	Dec. 27, 1889 ...	Jan. 7, 1890
,, ,, ...	Jan. 9, 1890 ...	still interrupted.
Trinidad to Demerara ...	Dec. 19, 1889 ...	Jan. 8, 1890
Aden to Zanzibar	Jan. 8, 1890 ...	Jan. 9, 1890
Suakim to Djedda	Jan. 8, 1890 ...	Jan. 9, 1890
Punta Rassa to Cay West ...	Jan. 18, 1890 ...	still interrupted.

Brazilian Telegraphs.—M. Joao Nepomuceno Baptista has been appointed Director-General of the Brazilian telegraphs in place of Baron Capanema, who has been dismissed.

The Largest Theatre in the World Lighted by Electricity.—The Auditorium in Chicago, the largest theatre in the world, has just been solemnly opened in the presence of President Harrison, Madame Patti lending her aid and being overwhelmed with applause after singing "Home, Sweet Home." The Auditorium is lighted by 10,000 electric lamps. The largest theatres in the world, after the Auditorium, are those of Milan, Naples, Hanover, Munich, Berlin, Dresden, St. Petersburg, Moscow, Bordeaux, and Paris.

Postal Statistics.—Germany has 19,476 post-offices, and England 17,587, while France has but 9,346.

Electricity in the Dissecting Room.—The Anatomy School of Trinity College has been fitted with 78 incandescent lamps of 25 candle-power each, arranged in groups of four and fixed over the dissecting tables. The lamps are fed by an overhead cable, the motive power being supplied by an "Otto" silent gas engine of 7 H.P. nominal. In connection with the engine are two centrifugal pumps, by means of which the drainage of the college park is pumped a height of 12 feet and discharged into the city sewers.

Telephonic Communication between St. Helens and Birmingham.—The first message from Birmingham to St. Helens on the new extension wires of the National Telephone Company was transmitted on Friday *viâ* Manchester. A firm of manufacturers in St. Helens, being rung up, were informed that they were connected with Birmingham, and the voice of a representative of a firm in that town was distinctly heard. Telephonic communication will shortly be available between St. Helens and London.

Telegraphic Wires over the Forth Bridge.—Telegraphic communication between the North and South and Scotland has hitherto been maintained by means of cables under the Forth, but the erection of the bridge has rendered the subaqueous lines, which owing to the damage frequently caused by ships dragging their anchors have proved very expensive, unnecessary. It is now proposed to remove most of the cables in the Firth. Altogether 50 wires are being laid across the bridge, enclosed in two tubes—20 for the use of the railway company, and 30 for the use of the General Post Office. The wires, which are of the usual kind for such purposes—copper insulated with gutta-percha—are being drawn through the tubes—two-inch iron pipes—in lengths of 118 yards and 250 yards.

The Electro-Harmonic Ladies' Night.—The Musical Directors will be glad to hear from any members or friends of this Society who are willing to take part in the Amateur Concert of the 28th inst.

Electrical Prize in Belgium.—The Brussels *Moniteur* publishes the report of the jury appointed to judge the papers sent in for the mixed competition of 1888, opened by the King of the Belgians, and having as its object: "The best work on electricity as a motor and as a means of lighting, on the applications which are or may be made of it, and on the economic advantages likely to result from the employment of electricity." The international jury, presided over by M. Montefiore Levy, Senator, has placed first among the works submitted for competition, "The Elementary Treatise on Electricity and Magnetism," by MM. Van Ryssel-berghe, E. Lagrange, and G. Royers; but, while recognising that this work answers more exactly than any other to the object of the competition, the jury regrets to state unanimously that it cannot award the prize. The secretary reporter to the jury was M. Eric Gérard, director of the Liége Electro-Technical Institute.

Telegraphists' Grievances.—A meeting, the first of a series of similar gatherings intended to be convened in all the chief centres throughout the kingdom, was held at Plymouth last Saturday week on the subject of Post Office and telegraph clerks' grievances. It was stated that it was intended to agitate for the abolition of classification, the right of probationers to have their appointments confirmed on passing a fixed qualifying examination of proficiency, payment for Sunday duty as overtime, compulsory retirement at the age of 60, a limitation of a day's labour to seven hours, making a working week of 42 hours, payment for overtime at the rate of time and a quarter, the adoption of a graduated scale of salaries, commencing at 12s. a-week on entry as probationers, and increasing by small annual increments until a maximum of £200 a-year was reached, and an immediate increase of all second class clerks who entered the service prior to the application of the Fawcett revision. The London clerks, it was explained, received exactly double the ordinary pay for Sunday duty. A resolution in support of these views was unanimously carried by the meeting.

Stoppage of promotion and transfer, including super-session, was the punishment recently awarded to eight telegraphists of Cardiff, suspected of having written a letter concerning their grievances to a local paper and of being unwilling or unable to prove their innocence when called upon to do so. The affair is said to have created a painful sensation throughout the service.

Telephonic Communication with London.—The new telephone line mentioned last week, which has been constructed from Manchester to Edgware, will shortly be extended to the centre of the metropolis. The line is a complete metallic circuit of copper wire ($11\frac{1}{2}$ gauge), so arranged on the posts that the direct and return wires cross each other at every span, in order to neutralise the inductive action which has hitherto interfered with success. An ordinary Blake transmitter, with magneto-machine, and Bell receiver are employed, and no special arrangements have been found necessary beyond the construction of the new line, arranged so as to be independent of neighbouring wires. The route followed is at present a devious one of 248 miles, being run through Ashton-under-Lyne, Sheffield, Birmingham, St. Albans, and Hendon to Edgware. A more direct route through Stockport, Macclesfield, Congleton, Stafford, Wolverhampton, Birmingham, St. Albans, and North London is nearly complete. There will then be, by each route, two independent circuits, one of each intended to work from Liverpool to London, and the other from Manchester to London. In arranging the routes no little difficulty has been experienced in obtaining the requisite "way leaves."

Sir John Bennett on Electricity.—At the weekly meeting of the Balloon Society held at St. James' Hall, last week, George Offor, Esq., in the chair, Sir John Bennett lectured on "Electric Powers and the Light of the Future." A resolution was afterwards carried on the motion of Sir John, who always takes time by the fore-lock, advocating the claims to encouragement of the Edinburgh Electrical Exhibition to be held this year. The following resolution was also moved by the President (W. H. Le Fevre, Esq., C.E.) and was unanimously adopted—"That in the opinion of this meeting the time has arrived for the general supply of electricity for light and power, and that such business should be in hands of companies formed for the purpose rather than be undertaken by public authorities."

River Currents to Generate Electricity.—An electric railway, 250 miles long, from Atlanta, Ga., to Savannah, has been planned. The electricity will be generated by utilising power from the currents of rivers along the route.

Electric Railways in the States.—A decision has just been reached, in accordance with which all the lines in Minneapolis will be equipped with electric motors. In St. Paul, also, a large part of the street railway system will be worked in the same way. It is, says the *Western Electrician*, the boast of the residents in this flour city that in a short time they will be able to ride over 100 miles of electric railway. The system has worked splendidly in cold weather and heavy snow-storms.

Electricity at Sea.—The arc lamp has been superseded by sunbeam lamps and groups of lamps of high candle power for steamship lighting, as the latter require considerably less attention. The single wire system of distribution is also found to be better adapted for this purpose as having less effect upon the compass.

Concerning Rubber.—According to the New York *Standard*, a Rubber Trust has been formed at Trenton, N.J., and British capitalists will own $3,000,000 worth of stock. There are eight rubber companies in Trenton, and higher prices, lower wages, and bigger profits may be looked for.

A New Journal.—No public movement, society or industry, now-a-days, is without its "journal," and the Council of the London Society for the Extension of University Teaching, in issuing one of its own, is only following a recognised custom, for which no apology was needed. The first number of this very neat publication contains a variety of interesting matter, and, so far as may be judged from a first issue, the journal appears to be well adapted to its object—viz., the means of bringing the society's various local centres more closely together, and of developing *esprit de corps* among its students.

Barnsley Wants Tenders.—The Barnsley Town Council invite proposals from electric lighting companies for the establishment in Barnsley of an electric lighting plant, and the supply of the electric light both for public and private purposes within the borough, in accordance with the Electric Lighting Acts, 1882 and 1888, and the provisions of the Barnsley electric lighting provisional order when obtained. Maps of the borough, with copies of the form of proposal and conditions, and of the draft provisional order, together with other information, may be obtained on the personal application of a representative of any electric lighting company to Mr. J. Henry Taylor, C.E., borough surveyor, Barnsley; or to Mr. Henry Horsfield, town clerk, Church Street, Barnsley. Proposals, properly sealed and endorsed, must be delivered to the Town Clerk by 10 a.m. on the 28th inst.

Removal.—Messrs. Allpress and Belshaw have removed from No. 49, Victoria Street, to more commodious premises at No. 55, Victoria Street, S.W.

Electrical Superintendent for Dublin.—The City Corporation at their weekly meeting on Monday last, the 3rd inst., decided to sanction the appointment of an electrical superintendent at £200 a year, for the purposes of electric lighting, &c. No names were mentioned, nor was it stated whether the Corporation would advertise for candidates.

Electric Plant Required in North London.—For supplying and fixing a dynamo, cables, wires, lamps, fittings, &c., for lighting by electricity the workhouse extension, infirmary, pavilion and board-room, and offices at Homerton, for the Guardians of Hackney Union. Persons desiring to tender may obtain specifications, conditions of contract, and form of tender by applying to Mr. Walter Barnett, surveyor, Winchester House, Old Broad Street, E.C., and paying a deposit, which will be returned to persons sending *bona fide* tenders in the manner and at the time specified. The contractor will be required to give approved security for the due performance of the contract. Sealed tenders, endorsed "Electric Lighting," must be delivered at the office of Mr. J. Owen Perry, clerk, Homerton, N.E., by 1.45 p.m. on 12th inst.

Testimonial to a Liverpool Electrician.—On Friday last, 31st January, the inspectors and over fifty workmen of the Liverpool Electric Supply Company dined together at the Falcon Day Hotel, Lord Street, the occasion being the presentation of a handsome marble timepiece, bearing a suitable inscription, to the retiring chief inspector, Mr. A. Lester Taylor, who is about to commence business on his own account.

Quick Work.—Perhaps the quickest piece of work in connection with electric lighting that has ever been accomplished in the Old or the New Worlds was last week completed in Burleigh Street. On Wednesday evening of last week, says *Tit Bits*, we sent over to ask if Mr. Verity, of King Street, Covent Garden, the electrician, could come over and see us; and on his arrival we said to him:—"This room, Mr. Verity, gets so hot in the evening with the gas that we can't stand it any longer. We want to have the gas taken out and the electric light put in by to-morrow evening." Mr. Verity looked first incredulous as to whether we were in earnest; but seeing we were, he reflected a moment and then replied, emphatically:—"You shall have it done." The next evening at four o'clock the editorial rooms were lighted by electricity, although until the previous day at six p.m. no one had received any order or instructions in the matter.

Subway Explosions.—The New York *Electrical Review*, in its latest issue, remarks that "the subway explosions in that city are becoming very numerous. Last weak beat the record; four large explosions occurred, blowing up manholes and a large portion of the surrounding pavement. Fortunately, so far, no one has been injured, but it certainly is only a question of time when innocent pedestrians will be seriously injured by an explosion beneath their feet. We are afraid that there is very little to be commended in the entire electrical subway system in this city."

Hope for Gas Companies.—According to the *Moniteur Industriel*, in certain great cities like Berlin, Hamburg, Stockholm, &c., where great progress has been made in electric lighting within the past two years, there has been a simultaneous increase in the consumption of gas.

Electricity on the Nile.—The Khedive has given orders for electric lighting of his yacht the *Feiz-Rabani*.

Electricity in Upper Silesia.—The use of the electric light has become general in the industrial districts. Nearly all the mines have their surface works lighted by arc lamps.

Another Fatal Accident.—While a lineman was repairing an electric wire at Cincinnati early this week he received an electric shock, causing him to fall from the pole to the ground, a distance of 30 feet. The man received fatal injuries.

Marriage of Earl Russell.—Yesterday, Earl Russell, the partner of Mr. James Swinburne, was married to Miss Mabel Edith Scott, younger daughter of the late Sir Claude Edward Scott, and Lena, Lady Scott, of the Hurst, Walton-on-Thames. It is said that amongst the numerous and costly wedding presents was a "hedgehog" transformer, from an anonymous donor.

The Institution of Electrical Engineers.—On Thursday next, at the ordinary general meeting, at 8.0 p.m., Mr. Jas. Swinburne is announced to read a paper on "The Theory of Armature Reaction in Dynamos and Motors."

NEW COMPANIES REGISTERED.

Mutual Telephone Company, Limited.—Capital £100,000 in £10 shares. Objects: To establish in such places in the United Kingdom as the company may determine upon, a telephone exchange or exchanges, and to establish and conduct any system of telephonic communication. To acquire patent rights and monopolies for the use, sale or manufacture of telephones, telephonic apparatus, or of any electric apparatus. Signatories (with one share each): G. Halilo, 100, Portland Street; E. Guthrie, 71, King Street; W. Thompson, 79A, Princess Street; W. M. Molleson, 105, Princess Street; E. A. Hague, 6, Dickinson Street; W. Wadsworth, 4, Albert Square; A. Forrest, Holt Town; all of Manchester. A. D. Provand, 9, Bridge Street, Westminster. The signatories are to appoint the first directors, qualification 10 shares. The company in general meeting will determine remuneration. Registered 4th inst. by Rowcliffes, Rawle and Company, of 1, Bedford Row, as agents for Needham, Parkinson and Slack, Manchester.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

"Electrician" Printing and Publishing Company, Limited.—This company filed its statutory return, made up to the 11th October, 1888, on the 1st inst. The nominal capital is £10,000 in £10 shares. 800 shares were taken up at the date of the return, and the full amount was considered as paid up thereupon.

The annual return made up to 31st December, 1889, was filed on the 1st inst. 940 shares have been taken, and upon 140 of these the full amount has been called and paid, the remaining 800 being considered fully paid. The shareholders are: Sir John Pender 360 shares, James Pender 50 shares, John Denison Pender 50 shares, Sir James Anderson 140 shares, Kenneth Anderson 100 shares, Louis Floersheim 190 shares, Louis Schott 50 shares.

Transvaal Oil Engine Company, Limited.—An agreement of 19th December, 1889, between this company and the Hamilton Syndicate, Limited, provides for the assignment to the company of certain patent rights in consideration of £3,000 fully paid up shares of £5 each.

Taylor and Challen, Limited (mechanical, electrical and general engineers).—An agreement of 9th November provides for the purchase by the company of the business, manufactory and premises of Messrs. Taylor and Challen at the Derwent Foundry, Constitution Hill, Birmingham, for £18,279 2s. 4d., payable by the allotment of 2,400 shares of £10 each, credited with £7 10s. as paid upon each, and £279 2s. 4d. in cash.

Priestman Oil Engine American Syndicate, Limited.—The registered office of this company is at Temple Buildings, Kingston-upon-Hull.

Lange and Company, Limited (electricians).—The registered office of this company is at 23, Billiter Street, E.C.

Norwich Electricity Company, Limited. — The registered office of this company is situate at Gothic Works, King Street, Norwich.

CITY NOTES, REPORTS, MEETINGS, &c.

Taunton Electric Lighting Company.

THE annual meeting of the Taunton Electric Lighting Company, Limited, was held on Monday evening at the Castle Hotel, Taunton.

The Chairman (Mr. J. H. Bale) having read the report, moved that the report be adopted, and that a dividend of 5 per cent., free of income tax, be declared payable on and after February 11th, 1890. Referring to the work of the past year, he said that they would doubtless remember that in the report issued twelve months ago there was an intimation that they were about to purchase improved machinery, which would have the effect of saving a considerable sum in the cost of fuel, &c. Early in the year, however, the directors gave their careful consideration to the procuration of a new site for their depôt, and they secured by public auction a piece of land, situated very near to their "friends the enemy"—the Gas Company. No sooner had the purchase been effected than the town was visited by a most disastrous flood, which rendered their recent acquisition about as visible as if it had been at the bottom of the deep blue sea. That being so, the directors were very much concerned as to the future of the site, and it was suggested that to utilise that land they would have to build arches upon which to erect machinery. This would have involved an additional outlay of about £500, an expense which they considered large and unnecessary. Under these circumstances they began to look for a more suitable site, and they had bought a piece of land which, he believed, would serve their purpose admirably, its situation being excellent in many respects. They had two entrances, and while being almost in the centre of the town, the machinery had been placed in such a situation that the least possible annoyance by the noise would be caused to the neighbours—indeed, they hoped that there would be no annoyance caused whatever by the machinery. They had now nearly completed their depôt, and the shaft was a land mark which could be seen a long way round Taunton, serving as a valuable advertising medium. The work of laying down the machinery was in progress, and they hoped in two or three weeks they would be in full working order, having quitted Fore Street for the splendid depôt in James's Street.

Mr. W. Potter seconded the adoption of the report, which was adopted.

Mr. Fowler, Mr. C. E. Lance and Major Winter, were re-elected directors.

At the request of the Chairman Mr. Down (of the firm of Messrs. Wharton and Down) stated that his firm last week got the contract for lighting one half of the streets of London and the monopoly of the private lighting. He expected they would get the contract the next day for lighting another town about as large as Taunton. He congratulated the company upon the valuable site they had secured.

Mr. Massingham proposed that "in future years the annual general meeting of the company be held any time during February that the directors might think fit." He said that by the articles of association they were obliged to hold the annual meetings on the first Monday in February, but the directors had found this to be somewhat inconvenient, as it followed too closely upon the end of the year, and the accounts had to be somewhat hurried through. As they were expecting to extend their business this difficulty would be increased, for it would take a longer time to prepare the accounts. He thought that the directors should be allowed to hold the meeting any time in February that was most convenient to them and the auditor. Referring to the affairs of the company he said that during the past year they had been placed at considerable disadvantage because of the large expenditure incurred, while the income could not be increased at anything like the same proportion, because they could not meet the demands of the would-be consumers. He then concluded by reviewing the work of the past year.

Mr. Goodman seconded the motion, which was carried.

A vote of thanks to the chairman terminated the meeting.

The Anglo-American Telegraph Company, Limited.

THE ordinary general half-yearly meeting of the proprietors was held in the Great Hall, Winchester House, on Friday the 31st day of January, 1890, at 2 p.m., Viscount Monck in the chair. The directors report and statement of accounts for the half year ending December 31st, which were laid before the meeting has already been printed in our last week's issue.

The Secretary having duly read the notice convening the meeting and also the minutes of the last general meeting,

The Chairman said he presumed that the report would be taken as read. In moving its adoption he was happy to be able to announce a small addition to the dividends. Undoubtedly it was small, but taken in connection with the explanation in the report he thought it not discouraging. They were aware that the company was carrying on its traffic under two distinct arrangements with the Direct United States Cable and the Western Union Company of New York. They had what was called a "joint purse" arrangement, *i.e.*, they paid their receipts into a common fund and received from that fund their proportions of the aggregate. On the other hand the parties to that arrangement and the Commercial Cable Co. of New York had an agreement by which the tariff had been fixed at a certain rate, and they each took as much as they could at that rate. That arrangement had, he believed, been fairly and honourably carried out by both sides, but nevertheless it introduced the element of competition, and that, in circumstances which might arise to interfere with the carrying capacity of either of the parties to it, would very prejudicially affect that party's income. That was precisely what had happened to their company during the past half-year. During that period one of their own cables—the old Brest-St. Pièrre cable of 1869—had been twice thrown out of work. The cable of the Direct United States Company had also been temporarily inoperative; and two cables of the Western Union Company had also been disabled, while during the whole period the cables of the Commercial Cable Co., their competitors, had been working uninterruptedly and profitably. He had only to reiterate, in regard to this, the observation made by his friend, the chairman of the Direct Cable Company (Sir John Pender), that it was the first duty of the directors of companies, in the Associated Union, to keep their cables constantly in repair, and, whenever a mishap occurred, to take care that the repairs should be effected with the greatest possible expedition. What he, the chairman, had mentioned was, of course, only the fortune of war, and they had no right to complain of it as against the Commercial Cable Company, and he only mentioned it as the reason why the directors were not able to distribute a larger dividend on the present occasion. However, their cables were now in good working order, he hoped they might continue so, and that the improvement which had taken place in trade all over the world might enable them to do better in the future. With regard to the expenses for the past half-year, although they looked larger than those of the previous half-year, if they came to analyse them they found that the increase consisted altogether of extraordinary expenses, reconstruction of buildings, and so on, which were unlikely to recur for a very long time to come, and which could not be treated as normal expenditure. During the period spoken of there had been spent upon these objects £2,600 in all, which exceeded very largely the excess of expenditure shown in the accounts of the previous half-year. Within the last year they had executed two works, one of which had been alluded to by his noble friend (Lord Tweeddale) at their last meeting, and related to the diversion of the St. Pierre-Duxbury cable into deep water. It had been for many years a source of vexation and expense to the company, owing to its liability to injury from the shallowness of the water in which it was laid; but he trusted that it would give no further trouble. The other was the financial arrangement, alluded to in the report, with the Western Union Company. They had obtained the command of cable lines into New York City, where they had established an office of their own. Those lines would not only place them in direct communication with their customers in New York, and would obviate the inconvenience of which his residence in America enabled him to speak, viz., the constant interruptions to the land lines in winter and spring by sun and storm. Now, as to the renewal fund, they had often had discussions with regard to it in that room. He had no desire to raise any questions about it on the present occasion; but it might be satisfactory to them to know that the fund, which now stood in their books at £923,344 18s. 4d., had been so well invested that it was worth at the present day about £60,000 more, and would give them, with the spare cable in reserve, a full million sterling for any purpose they might desire to apply it. That, he thought, was not an unsatisfactory state of things. The chairman then announced that Mr. Charles Burt had been chosen to fill the vacancy on the board occasioned by the death of Sir Daniel Gooch, to whose intellectual ability and high moral attributes he paid an eloquent tribute, and he concluded by moving: That the report of the directors and accompanying statements of account to December 31st, 1889, submitted to the meeting, be received and adopted; and that the following dividends, less income tax, as recommended by the board, be now declared and paid; that is to say, first, a final dividend of 15s. per cent. on the ordinary consolidated stock for the year ending December, 1889, making, with £2 10s. per cent. interim dividend already declared and paid by way of dividend on account, a total dividend for the said year of £2 15s. per cent. on the said stock; a final dividend of £1 10s. per cent. upon the preferred ordinary stock for the year ending December 31st, 1889, making, with the 4 per cent. interim dividend already declared and paid by way of dividend on account, a total dividend for the said year of £5 10s. per cent. upon the said stock.

The Marquis of Tweeddale seconded the motion.

Mr. Jackson, with reference to the litigation with the Paris and

New York Telegraph Company, urged the directors to use their best endeavours to bring it to a satisfactory issue. He thought, also, the shareholders had good reason to call upon the directors to give effect to Sir John Pender's statement at the meeting of the Direct Cable Company, viz., that something ought to be done to increase company's revenue. The record of their company after 24 years of existence, and with a board composed of gentlemen of the greatest experience and intelligence, one, in fact, of the strongest boards in the City, was certainly not a brilliant record. On the face of it they only enjoyed a dividend of 2¾ per cent., which was really 2¼ per cent., for the shareholders would have observed that the total repairs shown by the renewal accounts for the two half years amounted to more than a half per cent. dividend on their returns. That was paid out of the interest of their own accumulations. Two and a quarter per cent. was certainly not a brilliant result, or one which they could congratulate their excellent board upon. When he joined the company the first tariff was a £20 message, the next a £10 message, and next, through a brilliant discovery on the part of the board, telegraphists had been given an opportunity of condensing their messages and reducing the expense of messages, so that in 24 years the cost of messages had been greatly reduced. They had not stopped there: by means of codifying, which had become quite a high art, twenty words would now be expressed by one, and the codists got the full benefit of that also; but it was not a fair condition of things for the shareholders. The board ought to direct its attention to it and see whether something could not be done for the benefit of the shareholders.

Mr. Wood expressed himself as astonished with the last sentence of paragraph 1 of the report, which says that for some weeks during the half year under review the whole of the traffic had been thrown on the cables of the company, and in consequence its volume had been sensibly diminished, seeing that he had been given to understand that the carrying capacity of the company was far in excess of the business it had to do. As to the dividends not being very brilliant, he was very thankful they had not been worse. They might at any rate congratulate the directors on having a reserve fund with stores of cable amounting in value to one million sterling. That gave the company a backbone, consolidated it, and made it a very much safer investment than a great many that might be mentioned.

A Shareholder desired to know the sum total of the repairs during the past half year.

The Chairman: £17,800 plus the renewal fund.

The Shareholder strongly objected to this method of stating it. It was misleading to the public. He could not congratulate the directors on their report. He thought they ought to have two committees, one to attend to the electrical and the other to the financial part of the business. The company could not even pay a 3 per cent. dividend, and if the directors had taken from their fund the absolute cost of keeping up their cable, there would not have been even this 2¾ per cent. dividend; therefore that dividend was misleading. They were actually robbing their deferred shareholders in order to keep up the dividend for the others. To divide their expenses with the renewal fund was not a proper way of keeping their accounts. The whole expenses ought to have been put down to the expenses of working the cable.

Another Shareholder said the matter referred to by the last speaker was merely a question of bookkeeping. He did not think the shareholders need interfere with the directors' way of keeping their accounts, so long as the broad results were as they stood.

The Marquis of Tweeddale, replying for the Chairman, was able to assure the meeting, with regard to the litigation with the Paris and New York Telegraph Company, that everything had been done that could be done, by the intelligence of lawyers and able management, to expedite a settlement. He need hardly point out that the directors were unable to bring any influence to bear upon the French Courts. They had, however, every reason to believe that the case would be settled before their next meeting, six months hence. With regard to Mr. Wood's question with reference to the last part of the first paragraph of the report, it was, he thought, sufficient to point out that a company which loses three of its cables must be crippled in respect of its traffic. The traffic with America was crowded into a very few hours, and, of course, the more cables the company had at its command, the more expeditiously was that traffic conveyed. With regard to the suggestion that something should be done to increase their income, that, he need hardly say, was the chief, if not the only, occupation of directors. But gentlemen must remember that they were not in the position to fix the tariff. Not only had they very important and influential partners in this business, but they had also very powerful opponents, and until they all agreed and became a happy family in respect to this tariff, it was impossible to make an alteration, even if an alteration were desirable. But he thought the general impression was that an alteration was not desirable. The tariff ought to be exactly suited to the kind of traffic they had to convey. If they increased the traffic there would be every reason to believe they would only bring in further competition. They must always bear in mind that the traffic was open to any number of persons who might choose to spend their money or lose it in laying down cables. That really was the difficulty which this and other companies had always to contend with. With regard to another objection, the total cost of repairs and renewals was composed of two items—viz., £17,801 4s. 9d. under two heads of revenue, and another sum of £17,000 odd charged to the renewal fund, making a total of £35,650.

Viscount Monck and Mr. Samuel Barber, retiring directors, were unanimously re-elected; and Messrs. Dean and John Gane were appointed auditors at a remuneration of £100 each.

The meeting closed with a vote of thanks to the chair, moved by Mr. Jackson.

City of London and Southwark Subway Company.

In the report, the directors state that during the past half-year the works of the subway have made considerable progress, and are now approaching completion.

The work of driving through the wet bed of gravel at Stockwell has been steadily proceeded with, and one of the tunnels is now completed throughout, and the other tunnel is being rapidly advanced. The underground stations are all nearly finished, and the station buildings on the surface at Great Dover Street are roofed in, the alterations to the building at King William Street have been completed, and the company's offices are now established there. The hydraulic lifts are being erected at King William Street and Great Dover Street Stations, and the rails have been laid in both tunnels from the City to the Elephant and Castle, and also for a considerable distance on the Stockwell extension. At the depôt at Stockwell the boiler house has been completed and six boilers fixed. The engine house is nearly ready for the reception of the engines and dynamos, and the carriage sheds are being erected. The inclined road leading from the depôt to the tunnels is nearly finished. Messrs. Mather and Platt have had an electric locomotive and carriages running experimentally for some time between the King William Street and Great Dover Street Stations.

As the present authorised lines stop at Shadwell, about a mile short of the great centre of traffic meeting near the "Plough" at Clapham, your directors have deemed it advisable to deposit a Bill in Parliament asking for power to extend the line to that point, the works for which can be carried out at a lower comparative cost than the existing works, and the approval of the proprietors will be asked at a special meeting called for that purpose. They propose also to alter the name of the company to that of the City and South of London Railway Company, as being more in harmony with the present nature and object of the undertaking.

Powers are being sought in the ensuing session of Parliament by an independent company for the construction of an underground railway on the same principles as the City of London and Southwark Subway, from Bayswater along Oxford Street and Cheapside to the City, with a junction with our line at Arthur Street West, just before it enters the King William Street Station. The junction as at present proposed would not be satisfactory to this company, but it is possible that arrangements may be made to effect a junction between the two lines beneficial to both companies. It has also be deemed expedient to include powers in the company's Bill for the acquisition of the necessary land for the construction of a station near London Bridge Terminus of the London, Brighton and South Eastern Railways.

The directors who retire by rotation are Messrs. C. S. Grenfell and Alexander Hubbard, who are eligible for re-election.

The auditors likewise offer themselves for re-election.

The Cuba Submarine Telegraph Company.

The thirty-seventh ordinary general meeting of the company was held at the company's offices, 58, Old Broad Street, on the 5th inst., Mr. Thomas Greenwood in the chair, when the following report and financial statement were laid before the shareholders.

The directors beg to submit, duly audited, the balance sheet and accounts for the half year ended 31st December last. From these it will be seen that the gross receipts (including the balance brought from last account) amount to £19,705 18s. 2d., and the gross expenditure (including the half of the annual payment on account of the 1881 cable, and the expenses in connection with cable repairs) to £8,101 6s. 8d., leaving a sum of £11,604 11s. 6d. to the credit of revenue account. Of this the sum of £1,000 has been added to the reserve fund, increasing that fund to £91,000.

The dividend on the preference shares will absorb £3,000, and leave £7,604 11s. 6d., out of which the directors recommend the payment of a dividend on the ordinary shares at the rate of 9 per cent. per annum, free of income tax, the balance, £404 11s. 6d., being carried forward to the current half year's account.

The gradual and continuous increase in the income of the company, together with the accession of business on the opening by a French company of telegraphic communication from this company's terminus in Santiago to Venezuela, warranted the expectation that a large reduction might be made in its through tariff without materially affecting the shareholders' dividend, and with a view to secure by its lines the permanent carriage of the French company's through traffic to and from America and Europe and also to increase the traffic to and from the West India Company's system, the rate for all through messages was reduced about 25 per cent. from 1st July last. It is very satisfactory to note that the aggregate receipts have suffered comparatively little by the change.

But the directors regret to have to report that although the through rate has been thus reduced and all other proper facilities given to the French company, that company has applied to the Spanish Government for permission to have a line by land, or a cable by sea, almost parallel with the lines owned by this company. Protests have been lodged by the board with the Spanish authorities, but apparently without avail, for a Royal order has been issued refusing the land line, but conditionally granting a

cable from a place adjacent to this company's eastern terminus at Santiago (with which town the French Company already has telegraphic communication), along the north coast to Havana, this company's western terminus, so that the proposed line, if allowed, will take from this company the whole of the traffic under the control of the French company, but now carried by this company, and may be in competition, by the north coast, with this company's lines on the south coast. The board has therefore felt it to be imperative to commence proceedings in the proper court in Madrid to protect this company's concession and interests.

The duplication of the line between Batabano and Cienfuegos has been postponed until the next favourable season. The tenders invited by the board were not completed, but were under the consideration of the cable manufacturers when the strike difficulties commenced. The tenders were very much higher than the board expected them to be, and as the existing cable was working satisfactorily, the delay of a few months was deemed to be desirable. That cable has lately been broken by a ship's anchor, but has been speedily repaired, and is now at work as usual.

The Cienfuegos-Santiago 1875 cable, being faulty at both ends, will be repaired as soon as possible. The traffic is carried by the 1881 cable.

In accordance with Mr. Low's request he has been relieved of his duties as chairman, which have been undertaken by Mr. Greenwood, but the directors are pleased to add that Mr. Low retains his seat on the board.

The Secretary having duly read the notice convenning the meeting,

The Chairman said he presumed the report might be taken as read, it having been in the shareholders' hand for some 7 or 8 days. After a brief reference to the retirement of Mr. Low from the chairmanship, he said the company's expenses had been about £1,500 more, and the receipts about £1,500 less than twelve months ago. The two sums together made a difference in the company's availabe balance of about £3,000, and would account for the fact that only £1,000 had been carried to the reserve fund, as against the £4,000 of the corresponding period of last year. The whole of that expenditure had been in connection with the repairs to the Batabano-Cienfuegos cable and the amount paid to the Government for the use of wire in the short time during which that cable was disabled. They could not expect to carry on a business of this kind without incurring some expenditure for repairs. The average expenses, including repairs to cables, during the past seven years, has been £2,038 per annum, and the £1,500 which they had had to charge to the revenue account for the past half year, had been only a very little over the general average. Three years had yet to come during which the charge for repairs, renewals and replacements, at the rate of £3,750 per annum must still be borne by the revenue, after which they would incur no further expense except in the ordinary course. As regards the £1,500 diminution in the receipts, though it might sound paradoxical to say so, it was nevertheless a very satisfactory feature. It represented a reduction of their tariff upon by far the larger portion of their business by some 25 per cent., and the board congratulated themselves at being able to make so large a reduction at the cost of so small a diminution in the average receipts. They hoped that owing to the increase of traffic which must necessarily come with the reduction of charges, they would get as much income as they had when the rates were higher. Manifestly no company could hold a monopoly such as this company had held without taking the requirements of the public into account, and they might expect their position to be much firmer and less likely to meet with opposition at the lower rate. In reference to paragraphs 5 and 6, he explained that Cuba was an island of some six miles in length and about as wide as it was long. The company's cables began at Havana, on the north side of the island, where they joined the cables of the Ocean International Telegraph Company, which continued the line from Havana to the coast of America. Messages to the West Indies necessarily went through that line *viâ* America and the Atlantic cables to Europe, and especially to London. The company's line was then carried overland from Havana to the south side of the island, where the company's sea cables commenced, until they reached Santiago at the east end of the island, where they joined the Panama system to Jamaica; and from there, passing San Domingo, which, be it noted, was not in telegraphic communication with the West India and Panama Company, it was carried on to the other West Indian islands. The company had entered into agreements with the West India and Panama Company, and the Ocean International Telegraph Company, by which it controlled the whole of the traffic to Europe and back again. But recently a French company started a line from Venezuela to San Domingo, and thence to the sea, not far from Santiago, where the company's line commenced. It then obtained permission to make a line to Cuba, after touching at an insignificant place, to Santiago, so that messages from Venezuela to Europe and back again passed *viâ* Santiago through the Cuba Submarine Company's lines. The company's revenue had been very considerably increased by the traffic which the French company had been able to bring to it, and they had hoped, by reducing their rate, to secure that traffic permanently. Referring to the matters set out in paragraph 6 of the report, he said, even if their proceedings in the Madrid court should be successful they had yet several things to consider before concluding that their traffic would be interfered with. The French company had yet to get the capital, and, even if it had the capital, would, he thought, think twice before laying it out. The cost of a line like the one contemplated would not be covered by less than a quarter of a million; and, in the absence of any special circumstance which would put a different complexion on the matter, he thought that the company would eventually find it much more profitable to send messages by the Cuba Submarine Company's lines at the reduced rate. He concluded by moving the adoption of the report and accompanying statement.

The motion was carried unanimously.

The Chairman then moved: That the following dividends for the half-year be now declared upon the shares of the company:—viz., 10 per cent. per annum, subject to income tax, on the preference shares; and 9 per cent., free of income tax, on the ordinary shares, payable after to-morrow.

The motion was seconded and carried *nem. con.*; and, with a vote of thanks to the chair, the meeting dispersed.

North Metropolitan Tramways Company, Limited.

THE fortieth ordinary half-yearly meeting took place on Wednesday, at the Cannon Street Hotel, Mr. Richardson in the chair. The financial position of the company was exceedingly good, a dividend being declared at the rate of 9¾ per cent. In the course of his remarks, the chairman, referring to the Barking Road section of their system, said that electric traction with them thus far had been a most successful experiment. They had got this line fully equipped, and so satisfied were they that they thought it well to go to Parliament to enable them to still further use electricity.

Mr. Jackson (a shareholder) considered that the Legislature could not find any objection to their scheme, and that the Bill would be granted.

Mr. Roberts desired to know what was the actual difference of the cost in working by electricity and horses; also whether electric traction would necessitate the relaying of the rails.

Another Shareholder asked if the present cost of working electrically—viz, 4½d.—would be likely to continue.

The Chairman, in replying to the questions, said that the cost per mile with horses would be about 5d. It would not be necessary to relay the lines. He would not enter into any guarantee as to the continuance of the rate of 4½d. per mile, but stated that was the cost at present.

At the extraordinary general meeting held at the close of the ordinary, the Solicitor read the clauses of the proposed Bill, after which the following resolution was passed:—

"That the Bill now read, and entitled a 'Bill to authorise the use of mechanical power upon the undertaking of the North Metropolitan Tramways Company, and for other purposes,' be and the same is hereby approved, subject to such additions, alterations, and variations as Parliament may think fit to make therein, and that the common seal of this company be attached thereto."

This was agreed to unanimously.

The India-Rubber, Gutta-Percha and Telegraph Works Company, Limited.

SUBJECT to audit, the company's accounts to 31st December last show the following result:—

Brought forward from 1888	£25,088
Net profit for 1889	56,800
	81,888
Less interim dividend paid in July, 1889, 5 per cent.	20,800
	£61,088

The directors have resolved to recommend a further dividend of 5 per cent. (making 10 per cent. for 1889), and to carry forward £40,288.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending January 31th, 1890, amounted to £6,249.

The Cuba Submarine Telegraph Company, Limited. The estimated traffic receipts for the month of January were £5,150 as compared with £3,221 in the corresponding month of last year. The receipts for the month of October, estimated at £2,900, realised £2,903.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of January were £2,415, against £1,880 in the corresponding period of last year.

The Eastern Telegraph Company, Limited. The receipts for the month of January 1890, amounted to £59,478 against £65,855 in the corresponding month of last year.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for the month of January 1890, amounted to £40,610, as against £41,820 in the corresponding month of 1889.

The Great Northern Telegraph Company, Limited. The receipts in January 1890, £19,600; corresponding months, 1889, £22,400; and of 1888, £21,400.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month of January, 1890, were £6,225.

West India and Panama Telegraph Company, Limited. The estimated traffic receipts for the half month ended the 31st January are £3,551, as compared with £2,900 in the corresponding period of 1889. The October receipts estimated at £4,470, realised £4,790.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 31st after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,993.

AUTOMATIC REVERSAL SIGNALLING ON LONG SUBMARINE CABLES.

THE ordinary "reversal key" has hitherto held its own against all rivals as a means of transmitting signals through long ocean cables. This is partly because it is extremely simple in construction and not liable to get out of order, but principally because all the different "curb keys" and "curbing" systems have proved unnecessary since the present system of signalling was adopted, viz., the insertion of condensers at both ends of the cable. The "curbing" is so well known that I shall not attempt any description here; be it enough to say that the condenser performs the curbing, for while it is being charged, say positively, a positive current of short duration enters the cable and produces a signal, and as soon as the key is raised the condenser is discharged, which is equivalent to a negative current flowing into the cable, thereby neutralising the effect of the former, or positive, current.

Very elaborate methods of improving the signals and increasing the speed of signalling by automatic senders have been devised from time to time, and Sir William Thomson's automatic curb sender stands as a monument to his mathematical skill carried into the domain of practical life. None of these, not even Thomson's automatic curb sender, have, however, met with any great favour or proved remarkably successful, and this is, apart from other considerations, mostly due to the fact, that the *working speed, on long cables, cannot be increased beyond the capabilities of an ordinary "reversal key."*

Being engaged in the working of comparatively short cables, say 500 to 900 knots, it occurred to Mr. Julius Timm, the Great Northern Telegraph Company's mechanician at Shanghai, that the speed of signalling through these cables might be increased and the signals improved by doing automatically what was done by the key manually; and after a series of experiments he arrived at the conclusion that certain modifications of the Wheatstone Automatic Transmitter and Perforator would answer his purpose perfectly, and at the same time to enable him to utilise the beautiful mechanical details of these instruments. This *automatic reversal-transmitter* devised by Mr. Timm, a description of which is given below, performs the work of the reversal key automatically, and produces the signals by means of currents of equal duration but of opposite sign for either dots or dashes, each individual signal being succeeded by a short interval of time during which the cable is connected to earth.

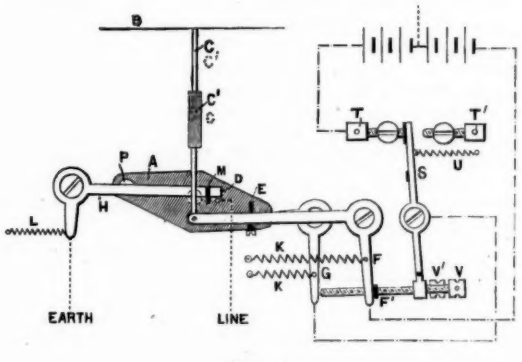


FIG. 1.

The principal parts of the transmitter are shown in their different positions in the figures 1—6, which are front views, and in figure 9, which is a plan view of the transmitting mechanism.

A is a pivoted ebony "rocking beam" pivoted on fulcrum pin, N, that is given an up and downward oscillating motion by means of a clockwork and crank, working on the pin, P. On the "rocking beam" is a platinum contact, D, connected to line, and an insulated stud, E. The levers F and G, with the needles, C C', pin-jointed thereto, are connected to the poles of the battery. The lever, H, is connected to earth, and so is the centre of the battery. The levers, F and G, are pivoted, and made to press against either the contact, D, or stud, E, by means of the springs, K. The lever, H, is also pivoted and rests on the contact, D, but as the springs, K, are stronger than the spring, L, the line only comes to earth through H, when the stud, E, takes the battery levers away from the contact, D. When one of the two battery levers for G rests on the contact, D, the lever, H, is removed from D by the ebony crosspiece, M. The motion of the battery levers is controlled by the holes in a perforated slip of paper, B, that, by means of the clockwork, is made to travel over the top of the needles. Fig. 7 shows a perforated slip of paper with the word

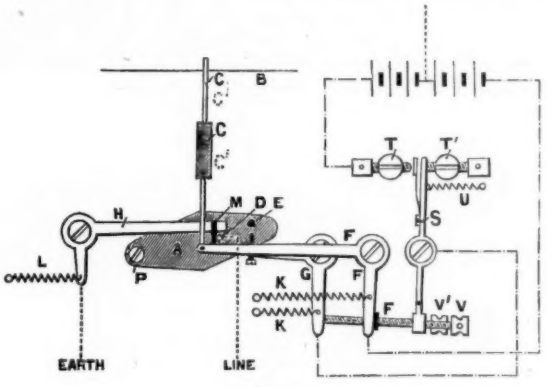


FIG. 2.

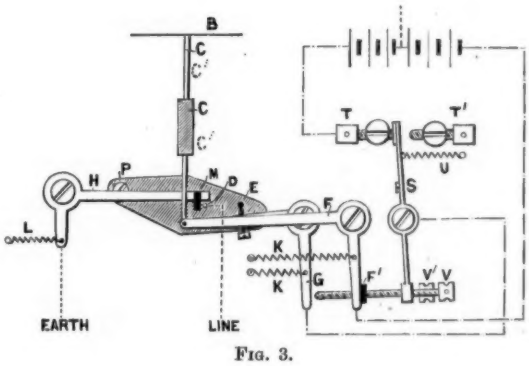


FIG. 3.

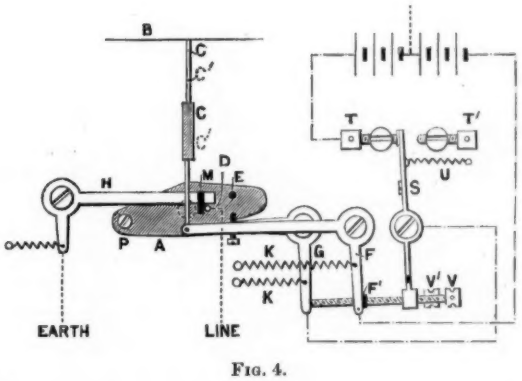


FIG. 4.

"gutta-percha;" and the actual printing of this word by the receiving instrument is shown in fig. 8. The upper holes on the perforated slip represent dots and control the lever, G, the lower holes represent dashes and control the lever, F. By means of the centre row of smaller holes the slip is made to travel through the instrument when working.

On the right-hand side of the battery levers is provided a switch, to prevent the battery from being short circuited when the instrument is set in motion with-

out any perforated slip being inserted. The action of this switch, with its tongue, S, moving between the contact screws, T, T′, is readily understood by referring to the figures. The lower part of the lever, S, is fork-shaped, and carries in each prong an adjustable screw, V, V′, placed just opposite the lower ends of the levers, F and G, respectively; V is prevented from coming into contact with F by the latter having a small insulated stopper, F′, inserted in its lower end, and the result of an up and down movement of the beam, A, is to send a negative current of short duration to line, and to put the latter to earth immediately after (fig. 1 and 2). When a perforated slip is inserted three cases may occur :—

(*a*) Fig. 3 and 4.—The needles, C, C′, meet no holes in the paper; that is to say, the line remains to earth through the lever, H, during the full up and down movement of the beam, A, as both battery levers, F and G, are now prevented from touching the line contact, D; consequently no current can be sent to line.

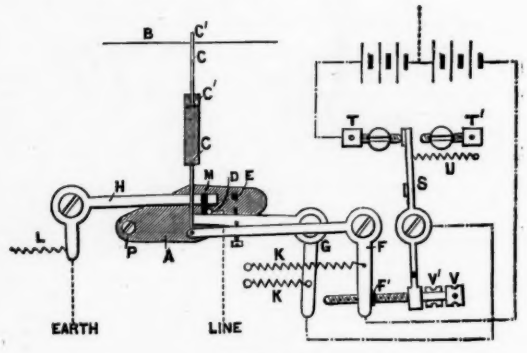


FIG. 5.

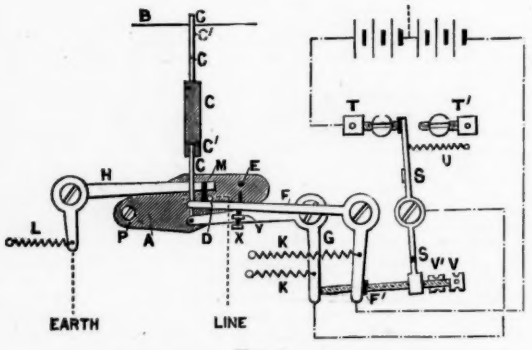


FIG. 6.

(*b*) Fig. 5.—Needle C′, on the lever, G, meets a hole in the paper; that is to say, the lever, G, only is brought upwards to touch and follow the motion of the line contact, D—the lever, H, being meanwhile

FIG. 7.

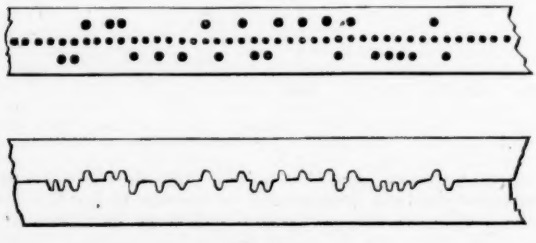


FIG. 8.

removed therefrom—and the positive pole of the battery is applied to line, until the stud, E, removes G from D, putting the line to earth through H, and assuming again the position shown in fig. 3.

(*c*) Fig. 6.—Needle, C, on the lever, F, meets a hole in the paper; that is to say, the lever, F, only is made to touch and follow the motion of D—H being again lifted away from D—and a negative current is now allowed to flow to line until the stud, E, takes the lever, F, away from D, thus bringing the line to earth through H.

In order to regulate correctly the functions of E, each of the battery levers, F and G, is provided with a small adjustable screw, Y and X, situate just below the insulated stud, E.

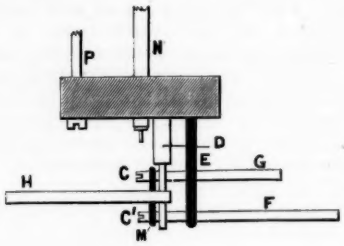


FIG. 9.

Since April last Mr. Timm's automatic reversal sender has been in use on the *Hongkong-Shanghai cables*. The operators much prefer the automatic signals to those sent by key, the former being clearer and more regular; and, as the reversal sender is easy to adjust and keep in good working order, there seems a prospect of its introduction by some of the leading submarine telegraph companies, at all events upon such cables which are not worked up to their maximum capacity by hand, and where a continuous stream of traffic throughout the 24 hours may be disposed of somewhat more satisfactorily by an automatic than by a manual system of working.

P. CHR. DRESING.

THE ARON METER.

SCIENTIFIC reports on new inventions are sometimes viewed with a little suspicion, especially when the invention has not had the advantage of prolonged public use. Dr. Aron's electricity meter is, however, not a new invention, and it has been employed for a number of years, there being several thousands working daily in England and on the Continent.

Considering its almost universal use, particularly on the Continent, it seems strange that no independent and complete testimony has found its way into print, therefore we deem it all the more desirable to reproduce the results of careful tests made by Mr. Gisbert Kapp, which demonstrate conclusively the accuracy of the Aron meter, both for alternating and continuous currents. Experience leads Mr. Kapp to the conclusion that the accuracy, long range and economy of power, make it a very satisfactory instrument, both for direct and alternating currents.

27th January, 1890.

Messrs. the General Electric Company, Limited,
71, Queen Victoria Street, E.C.

Gentlemen,—I have subjected the Aron meter, which you supplied, to a series of tests extending over about ten days, and now report to you on the results of these tests.

The meter consists of a pair of pendulum clocks so geared together as to register the difference in their rates on a set of dials. One of the clocks has an ordinary pendulum, whilst the bob of the pendulum of the other clock consists of a fine wire solenoid, placed horizontally and swinging within a fixed solenoid of much stouter wire, through which passes the supply current which is to be metered. The fine wire solenoid is connected in series with a resistance coil, and the two form a shunt to the supply leads. The connections are so arranged that there is attraction between the shunt solenoid and the main solenoid, and consequently acceleration of the electric as compared with the gravity pendulum; the difference in rate, which is registered on the dials, being very nearly proportional to the amount of energy passed through the meter in any given time. To find this energy we

have therefore to multiply the numbers registered on the dials by a coefficient, which must be determined for each meter by experiment, and which in an absolutely perfect meter should be a constant for all currents and pressures within the range of this instrument. I do not know any meter in which this coefficient is absolutely constant: it varies with the amount of current and the amount of variation is an indication of the greater or lesser accuracy of the meter. To judge of the merits of a meter it is therefore only necessary to determine the coefficient for different currents and pressures and to compare the coefficients with each other. The more nearly the coefficients agree the greater is the degree of accuracy attained by the meter.

I have tested your Aron meter at pressures varying between 130 and 95 volts, and with currents varying between 26 and 7 ampères, both direct and alternating. In addition, I have also made a prolonged test with a direct current of 0·65 ampères.

The meter is designed for a mean pressure of 100 volts and a maximum current of 25 ampères. I found that the co-efficient is practically unaffected by variations in pressure between the limits of 95 and 130 volts. The pressure was measured by a Cardew voltmeter, and by a Sir William Thomson electrostatic voltmeter. I calibrated the Cardew voltmeter by means of a Clark standard cell and its indications agreed perfectly with Sir William Thomson's instrument. The currents between 7 and 26 ampères were measured by a Sir William Thomson ampère balance, and the current of 0·65 ampères was measured by a Sir William Thomson deciampère balance. With the larger currents the readings were taken every quarter of an hour, and with the smaller currents they were taken at longer intervals. In this case the current was taken through a single lamp from a secondary battery, ordinarily supplying 40 lamps and was, therefore, absolutely constant over a period of many hours, rendering it unnecessary to take frequent readings. The tests at high voltage (from 110 to 130 volts) were made whilst charging the secondary battery, and those at normal voltage (from 95 to 105 volts) were made whilst supplying the lamps from the battery, when the current was direct; and whilst supplying lamps from transformer, when the current was alternating. The conditions of the tests were, therefore, those which obtain in the actual use of meters.

The co-efficient given by Dr. Aron for this meter is 1·07, that is to say, at about 100 volts pressure between the mains one division in the uppermost dial represents 107 Watt hours. I first tested the meter in exactly the condition in which it came to me and found that for currents varying between 25 and 15 ampères, the co-efficient given by the maker was nearly correct. For smaller currents the co-efficient was, however, incorrect and the error increased as the current was diminished. Thus with current required for one single lamp my test gave co-efficient of only 0·97. I found that this discrepancy was due to the fact that the meter had not been properly regulated before it was sent to me. In order that a clock meter of this kind may register accurately, it is necessary that the gravity pendulum should have exactly the same period as the electric pendulum when no current is passing. In this meter the gravity pendulum had a longer period, and consequently the meter registered, even when no current was passing. This defect can very easily be rectified, since the gravity pendulum is provided with a weight which can easily be screwed up or down as may be required, in order to bring the two pendulums to absolute synchronism. I found it very easy to make this regulation, and my subsequent tests were made with the meter so regulated. I mention this matter to draw your attention to the necessity of regulating every meter after it is installed.

Test of Meter with Direct Currents.—The meter being intended for a 40-light installation, it seemed advisable to test it within the limits of current which would ordinarily obtain in such an installation. I made, therefore, prolonged tests with currents of 8 and 23 ampères, which corresponded to 12 and 35 lamps respectively. The coefficients I obtained were the following:—

With 35 lamps, 1·130; with 12 lamps, 1·141.

I also made a prolonged test with a single lamp, in order to determine the accuracy of the meter at the lowest current at which it can possibly be used in practice. This test is for all meters the most severe, since any error, however small, absolutely becomes relatively large if the current to be metered is itself very small. I found that even at the lowest limit of current the Aron meter gave a remarkably accurate result, the coefficient being:

With 1 lamp ... ... 1·146.

On the basis of these figures it is now possible to form an estimate of the accuracy of the meter when in practical use. Taking the mean between the coefficients for 12 and 35 lamps, I find 1·1355 as the coefficient to be used with this meter. The maximum error which would obtain if the meter were always worked at the lower or always at the higher limit of current, would then be ½ per cent.; but as in practice the meter will generally be worked at intermediate currents, the probable error will be less than ¼ per cent. I need hardly say that this degree of accuracy is greater than that of any gas meter, and more than sufficient for all practical purposes.

Test of Meter with Alternating Currents.—As there must necessarily be some self-induction in the fine wire coil forming the bob of the electric pendulum, the shunt current must lag behind the main current, and the acceleration will be somewhat less than with a direct current representing the same energy. It will also be evident that the difference will be the greater the higher the frequency of the alternating current, so that the coefficient of the meter, as found by experiment with direct currents, will not be applicable if the meter is to be used with alternating currents, and a new coefficient must be experimentally determined for every frequency. I have accordingly tested the meter at two frequencies which may be considered limiting values for practical work, viz., 105 cycles per second (or 12,600 reversals per minute), and 70 cycles per second (or 8,400 reversals per minute). As regards current strength, I have in both cases made the tests within the same limits as those I adopted for the direct currents, and I give the results in the following table:—

Number of lamps supplied.		Coefficient for a frequency of 105		70
35	...	1·195	...	1·170
12	...	1·220	...	1·194

Taking, as before, the averages between these figures, I find that the coefficient to be used with this meter is:—

1·207 for a frequency of 105, and
1·182 for a frequency of 70.

In either case, the maximum possible error is about 1¼ per cent, whilst the probable average error will be considerably smaller than 1¼ per cent. This degree of accuracy, though not so great as that found with direct currents, is still quite sufficient for all practical purposes.

The energy absorbed in the meter varies with current passing through it. At a pressure of 100 volts the energy absorbed is:

With 1 lamp ... ... 3 watts.
With 12 lamps ... ... 4 „
With 35 lamps ... ... 9 „

My experiments lead me to conclude that the accuracy, long range, and economy of power shown by the Aron meter make it a very satisfactory instrument, both for direct and alternating currents.—Yours faithfully,

(signed) GISBERT KAPP.

ON GALVANOMETERS.*

IN fitting up the laboratories of the Central Institution, the authors have had occasion to obtain many galvanometers of various types, several of which are comparatively new. The results obtained from the comparison of the different instruments will, it is hoped, be of service in judging their relative excellence, and in suggesting further improvements.

The authors give two reasons for their opinion that sensitive galvanometers should be made astatic. Firstly, by so doing the working of the galvanometer is made more independent of outside magnetic disturbances; secondly, although both astatic and non-astatic galvanometers can theoretically be made infinitely sensitive by sufficiently weakening the controlling field, the practical limit caused by instability is reached sooner with non-astatic instruments than with astatic ones. The usual method of placing the mirror inside the coil is undesirable. In some instruments shown at the meeting, Mudford's improvement of placing the mirror outside the coil, or outside between the two pairs of coils when four coils are employed, had been adopted. The valuable parts of the coil near the suspended needle could thus be utilised. It was shown, however, that there was a small, approximately spheroidal, space near the needle, within which the convolutions would tend to oppose those in the more distant portions of the coil. A graphical method was given for determining this space, which space it is proposed to utilise by winding the convolutions within it in the opposite direction to that of the remaining ones of the coil. Details as to the methods of supporting the coils were then discussed, and the importance of fitting them in boxes mounted on hinges or otherwise, so as to be readily removable, was pointed out. A galvanometer devised for teaching purposes, and provided with variable damping arrangement, was described, in which the damping is effected by enclosing the mirror in a glass cell whose sides can be caused to approach or recede by turning a milled head outside the instrument. This arrangement enables the damping to be varied between wide limits, and its effect on the swing produced by a given discharge can be determined. The instrument is also serviceable both as an ordinary damped galvanometer or as a fairly ballistic one.

In measuring quantities of electricity by the first swing of a galvanometer needle, a correction has usually to be introduced for damping. This correcting factor is simple enough when the damping is small, but becomes more complex as the damping increases, and to facilitate the calculations, a table of values of the factor for various values of λ (the logarithmic decrement) has been calculated. From this it appears that for values of λ less than 0·5, the value of the factor is very nearly $(1 + \frac{1}{8}\lambda)$, the correction usually applied. Improvements in methods of insulating the coils and terminals of galvanometers required for insulation tests were next described, the principle of which may be gathered from figs. 107 and 108, in Prof. Ayrton's "Practical Electricity." A special form of instrument for high insulation work was exhibited, in which the copper resistance of the coils is

* Abstract of paper by Prof. W. E. Ayrton, F.R.S., T. Mather, and Dr. W. E. Sumpner, read before the Physical Society, January 17th, 1890.

nearly 400,000 ohms, and the shortest path along which surface leakage can take place from the coils or terminals to the base of the instrument is between 30 and 40 inches of ebonite in a space, artificially dried by sulphuric acid. This is attained by supporting the coils from two corrugated ebonite rods, which hang from a brass ring carried on the top of three corrugated pillars fixed to the base plate. The instrument was constructed to drawing by Messrs. Nalder Brothers, but the method of supporting the coils was suggested by Messrs. Eidsforth and Mudford.

With reference to the proportionality of deflection to current in reflecting galvanometers, it was pointed out that ordinary reflecting galvanometers may differ more than 1 per cent. within the limit of the scale, hence showing the necessity for calibration when any approach to accuracy is desired. Galvanometers of the D'Arsonval type sometimes differ from proportionality more than the one above referred to, but by fitting such instruments with curved pole pieces, and allowing the coil to hang freely from the top suspension, a proportionality true to less than 0·15 per cent. has been attained over a scale about 30 inches long. The following abstract of tests made indicate the amount of error which may arise :—

Ordinary Reflecting Galvanometer.

Deflection	0	120	240	360	480	600
Corresponding current	0	121·0	242·5	363·5	483	600

Ordinary D'Arsonval Galvanometer.

Deflection	0	120	240	360	480	600
Corresponding current	0	118·5	240·6	359·8	473·5	600

D'Arsonval Galvanometer with Curved Pole Pieces and Coil Hanging Freely at the Bottom.

Deflection	0	120	240	360	480	600
Corresponding current	0	119·9	239·9	360·2	480·7	600

Coming to the question of sensitiveness, the importance of keeping the wire as close as possible to the magnets was brought prominently forward, as well as the necessity of reducing the "figure of merit" of various instruments to the same standard in comparing their sensibilities. A satisfactory standard of comparison is, however, not easy to determine. The sensibility in use of any instrument is made up of many factors, some of which arise from the skill of the experimenter himself. It is also desirable to give the data in such a way that the influence of each factor can be separately determined. The authors have therefore endeavoured to distinguish as far as possible the three chief causes of the sensibility of reflecting galvanometers—viz., the arrangement and winding of the coils, the construction of the magnetic system, and the optical method of magnifying the angular deflection produced. With the same view the question of the susceptibility of various galvanometers to outside magnetic disturbances has been considered separately since first the electrical qualities of the instrument are not altered by such disturbances, and, secondly, their influence is dependent, not only on the kind of instrument, but also on the place of test. Galvanometers have therefore been classified in four divisions, according to their relative susceptibilities to slight variations of controlling field. The strength of the controlling field is supposed to be so adjusted that the returning moment arising from twisting the suspended parts through a unit angle from the equilibrium position is constant. The four classes, arranged in order of decreasing susceptibility to outside magnetic disturbance, then comprise non-astatic galvanometers working in a weak field and with strongly magnetised needles; non-astatic instruments working in a strong field and with needles not so strongly magnetised; astatic galvanometers working in a fairly strong field; and lastly, galvanometers of the D'Arsonval type working in an extremely strong field.

The optical sensitiveness of a galvanometer is dependent on many considerations which have no connection with the instrument itself. Thus the goodness of the mirror, the distance of the scale, &c., are important factors. The authors, hence, have contented themselves with giving the number of scale divisions per micro-ampere, or per micro-coulomb, assuming the scale to be placed at a distance from the mirror equal to 2,000 scale divisions. As the scale distance most generally used is a metre, and as the scale divisions are frequently in half millimetres, the conditions assumed are often fulfilled in practice. The sensibilities for a steady current, and for a discharge, are thus directly expressed in angular measure irrespective of optical magnification. The sensibility at the usual scale distance employed with each instrument is, however, given as a guide, for it must be remembered, in comparing sensibilities at the same period, that two instruments will differ although the instruments may be identical in all respects save the moment of inertia of the suspended parts, and these may differ because a larger and heavier mirror has been attached in order to employ a longer scale distance.

An important and difficult question to decide is whether the factor of merit of a galvanometer should be given under the condition of constant period, or of constant controlling moment, or of constant controlling field. The first is the easiest to obtain and to calculate from, and is most readily understood. In the table of data of the many instruments tested, only an abstract of which is here published, two columns have therefore been reserved for the values of D and S, which respectively denote the deflection per micro-ampere, and the swing per micro-coloumb, each in scale divisions when the period is 10 seconds and the scale distance is 2,000 scale divisions. The corresponding values at any other period, T, are of course $D\,T^2/100$ and $S\,T/10$. It is, however, unfair to judge the relative merit of two instruments by simply comparing their action when the period is 10 seconds in each case, for this period may be unsuitable for use with one or both of them. It is, moreover, not quite right to compare the values of D and S when the usual periods are employed, as these may not be all equally favourable to the instruments considered. The authors, therefore, determined to reduce the numbers to their corresponding values under the condition of constant controlling moment per unit angle. The alternative of constant controlling field was rejected because it is inapplicable to instruments of the d'Arsonval type. The stability of the zero of any instrument, however, depends on the controlling moment per unit angle, and the values of D and S (see table, columns 7 and 8) have, therefore, been multiplied respectively by I and $\sqrt{I}$, where I is the moment of inertia of the suspended parts in C.G.S. units. In this manner numbers proportional to the sensibilities for constant controlling moment have been obtained, and these perhaps give a fair comparison between the various instruments when the time required to take an observation is entirely unimportant. It should be borne in mind, however, that the period of instruments in which the moments of inertia of the suspended parts are large, such as Rosenthal, Gray, or ordinary D'Arsonval galvanometers would be inconveniently long.

The influence of resistance has next to be considered. If two galvanometers differ only in the gauges of wire with which they are wound, and the convolutions are similarly distributed, then the sensibilities should be proportional to the number of turns. If, again, the thickness of the insulating covering bears a constant proportion to that of the wire, then the resistance of the coils would be proportional to the square of the number of turns, so that the values of $D/r^{\frac{1}{2}}$, $S/r^{\frac{1}{2}}$ would be constants for the same pattern of instrument, where D and S are the number of scale divisions per micro-ampere and micro-coulomb respectively, and r is the resistance of the galvanometer. The proportion in question, however, varies not only for coils of different resistances, but also in the same coil, for several different gauges are generally used in winding the various portions. To get some idea of the relation between resistance and sensibility, the authors have made tests on galvanometers of the same pattern but of different resistances (the same magnetic system being used throughout), and have found that D and S vary approximately with the value of r raised to the power 2/5, *i.e.*, $D/r^{\frac{2}{5}}$ and $S/r^{\frac{2}{5}}$ are approximately constants for galvanometers of the same pattern. These quantities have accordingly been taken as the factors of merit of the galvanometers for constant period, and their values are given in the table. (See columns 10 and 11.)

Another question to be considered is the factor of merit in connection with the volume of the coils, as this is important as regards the cost of high resistance galvanometers. A separate column (5) is therefore given, showing the approximate volume in cubic centimetres occupied by the wire in each instrument and other columns (14, 15, 16, 17) give the values obtained by dividing this quantity into the various factors of merit. The results of comparison in these latter columns are very interesting. It appears that galvanometers of the Rosenthal or Gray, and the D'Arsonval types are by far the most sensitive in proportion to the volume of coil. The authors believe that the best way to make a very sensitive galvanometer with a movable magnetic system, is to employ several small coils instead of one or two large ones,* and that the magnets should be horseshoe shaped, with the line joining the poles vertical, as in Prof. Gray's instrument, but modified so as to give smaller moment of inertia. Such a magnetic system can be made very delicately astatic, and the weakening of the magnets with time does not greatly influence the astaticism. The authors also conclude from their investigations that the most sensitive galvanometer of all would be one of the D'Arsonval type suitably modified. The poles of the magnets should be very close together, the coil should be very small, and no stationary iron core should be used inside the coil as in the ordinary D'Arsonval instruments. The sensitiveness could be further increased by employing electro-magnets instead of permanent ones to produce the deflecting field.

Experiments have also been made on the coefficients of self-induction of galvanometer coils, and a table of values is given in the paper. From this it appears that a coil of ordinary size used in Thomson galvanometers has a coefficient approximately equal numerically to $\frac{1}{1000}$th of its resistance in ohms. If the coils of the instrument are in series, and placed near each other, as in actual use, the coefficient is increased by about half its former amount owing to mutual induction, so that for Thomson galvanometers whose resistance vary between 1,000 and 10,000 ohms the time constant is about 0·0015 seconds. Very high resistance instruments have a smaller time constant, owing to the increasing importance of the insulating covering of the wires. The authors also discuss the possibility of judging the electrical qualities of galvanometer coils by measurements of their induction coefficients.

The importance of having the magnets of galvanometers as strongly magnetised as possible is illustrated in a table showing the results of experiments made at the Central Institution. In many cases the sensibility of an instrument has been trebled (for the same periodic time of vibration) by simply remagnetising the

* Mr. C. V. Boys, F.R.S., in his Cantor Lectures on "Instruments for Measuring Radiant Heat" (April, 1889), has also shown that galvanometer with small coils may be made very sensitive (pp. 22, 23).

ABSTRACT OF TABLE.

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	Type.	Description.	1 r	2 M	3 D	4 S	5 V	6 I	7 D I	8 S I$^{\frac{1}{2}}$	9 D r$^{\frac{1}{2}}$	10 D r$^{\frac{3}{2}}$	11 S r$^{\frac{3}{2}}$	12 D I r$^{\frac{3}{2}}$	13 S I$^{\frac{1}{2}}$ r$^{\frac{3}{2}}$	14 D r$^{\frac{3}{2}}$ V	15 S r$^{\frac{3}{2}}$ V	16 D I r$^{\frac{3}{2}}$ V	17 S I$^{\frac{1}{2}}$ r$^{\frac{3}{2}}$ V
1	Thomson single coil ‡.....	Tripod pattern (Finsbury Tech. College)	0·6	3·8	7·6	...	...	...	...	...	10	9·4	5·9	...	...	...	...	...	...
2	,, double ,, ‡.....	Glass cylinder pattern (Fins. Tech. Coll.)...	4,600	1,220	2,440	1,520*	...	...	...	...	53	76	5·2	...	...	...	...	...	...
3	,, ,, ,, ...	Elliott's stock pattern†	7,000	4,300	7,110	4,450*	30	0·013	92	507	85	205	129	2·68	14·7	6·8	4·3	0·089	0·049
4	,, ,, ,, ...	,, larger coil pattern†	12,300	7,680	15,200	9,550*	240	0·013	196	1,090	137	350	220	4·53	25·2	1·46	0·88	0·019	0·10
5	,, ,, ,, ...	,, ,, ,, †	30,000	10,710	21,800	13,700*	240	0·013	284	1,560	126	353	220	4·6	25·3	1·47	0·88	0·019	0·10
6	.....	Prof. Langley's bolometer galvanometer ...	20	125	250	156*	...	...	...	...	56	76	47	...	...	...	...	...	...
7	Mudford imp. single coil	Foster-bridge galvanometer (Central Inst.)	26	347	349	220*	72	0·035	12	41	68·5	944	60	3·26	11·1	1·30	0·82	0·046	0·15
8	,, ,, ,,	Galv. for E.M.F. of cells by condenser method (Central Institution.)	2,457	1,375	2,160	1,360*	72	0·035	76	259	43·5	95·5	60	3·34	11·2	1·32	0·83	0·046	0·15
9	,, ,, ,, ,,	Galv. for E.M.F. of cells by Poggendorff's method (Central Institution.)	6,410	2,720	3,360	2,110*	72	0·035	118	396	42	101	63	3·54	11·8	1·31	0·87	0·049	0·16
10	,, ,, ,, double ,,‡	Wheatstone's bridge galv. (Fins. Tech. Coll.)	700	1,720	2,970	...	...	...	...	...	112	198	136	...	...	...	...	...	...
11	,, ,, ,, ,,	,, ,, ,, (Central Inst.) ...	686	1,660	1,600	1,010*	88	0·084	134	293	61	112	74	9·41	21·5	1·25	0·78	0·015	0·23
12	Mudford imp. double coil (large)	Variable damping ,, ,, ...	9,744	4,200	4,280	2,640	200	0·052	222	615	43·5	108	67	5·61	15·3	0·54	0·34	0·028	0·78
13	Mudford imp. double coil (large)	High resistance ,, ,, ,, ...	360,000	50,000	54,200	34,000*	236	0·01	542	3,400	90	324	202	3·24	20·2	1·37	0·86	0·014	0·066
14	{ Rayleigh, Gray } Two {	Rosenthal micro-galv. (C.I.) Non-astatic ...	44	229	25·4	16	0·29	1·5	38	31	3·82	5·6	3·5	8·40	4·3	19·0	12·1	28·5	14·8
15	{ or Rosenthal } coils. }	,, ,, ,, Astatic	44	25	27·7	17·4	0·29	0·70	19·4	23	4·2	6·1	3·8	4·27	3·2	21	13·1	14·7	11·0
16	Do. do. four coils	Profs. T. and A. Gray's instrument	30,000	32	64	40*	51	50	3,290	283	0·37	1·04	0·6	5·2	4·6	0·02	0·013	0·10	0·09
17	Do. do. ,,	Ballistic galvanometer (Central Institution.)	4,090	54	63	39·2	36	17	1,070	165	1·0	2·36	1·4	40	6·1	0·07	0·04	1·1	0·17
18	Deprez-D'Arsonval.....	Carpentier's ordinary make (Crompton's) ...	208	286	375	236*	...	...	...	...	26	44·3	27·9	...	...	...	...	...	...
19	,, ,, ...	Jolin's make, low resistance (Central Inst.)..	3·8	39	42	26·4*	0·60	5·5	230	62	21·5	25	15·5	13·4	36	41	26	225·4	61
20	Deprez-D'Arsonval (invariable sensibility)	Home made (Central Institution).....	21	190	181	114*	0·96	13	2,360	410	39·4	54	33·6	700	122	56	35	730	126

needles, and, in one case, the sensibility of an instrument had fallen to one-fifth of its original value by the weakening of the magnets with time and use. The experiments show that however carefully a galvanometer may be used, it is advisable to remagnetise the magnets occasionally.

In view of Mr. Preece's remarks at the Institution of Electrical Engineers, on January 23rd, on the deteriorating quality of magnet steel, it is of the first importance that, for sensitive galvanometer needles, only the very best quality obtainable should be employed.

Explanation of Table.

r = resistance in ohms.

M = millimetres deflection per micro-ampere when the period is 10 seconds and the scale is placed as in the actual use of the instrument.

D = deflection in divisions per micro-ampere when the period is 10 seconds and the scale distance is equal to 2,000 scale divisions.

S = swing produced per micro-coulomb under the same conditions as in last.

I = moment of inertia of suspended parts in C.G.S. units (only approximate).

V = volume in cubic centimetres occupied by the convolutions of wire (only approximate).

Column 12 gives the deflection in scale divisions (distance of scale from instrument equals 2,000 scale divisions) per micro-ampere when the controlling moment for unit deflection of the suspended system and when the total resistance of the coils is the same for all the instruments.

Column 13 gives the first swing per micro-coulomb under the same conditions.

* These numbers are calculated from the corresponding values of D.

† The constants of these instruments were kindly supplied by the makers.

‡ These instruments were tested after being in use for some years, the needles not being remagnetised.

THE BROOKLYN SUBWAYS.*

FINAL REPORT OF THE COMMISSION—INTERESTING REVIEW OF THE UNDERGROUND AND OTHER WIRE WORK IN BROOKLYN.

(*Continued from page* 132.)

Since a telephone wire usually earns only a rental, independent of its actual business, and the contract with each subscriber is terminable by him upon three or six months' notice, it is plain that unless a city be provided with subways reaching every house,† and permitting the introduction and removal of single wires without disturbance of pavements, neither the telephone company nor the city could endure the requirement that all the wires be put underground. The company could not spend hundreds or thousands of dollars to reach a subscriber who might cancel his contract after paying $25, and the city could not tolerate perpetual digging in its streets. Moreover, the only commercially practicable underground conductors of this class are cables containing 50 or 100 wires each, and these wires must be separated and carried overhead to subscribers. It would be reasonable to require of telephone companies that their overhead conductors should be made of hard drawn copper instead of iron. They could then be made so small as to be scarcely visible at the height of an ordinary building, while they would also present less surface to collect ice or to be assailed by wind. The supports might consequently be further apart; and, whenever practicable, should be house-top fixtures, or poles in retired alleys, courts, or the interiors of blocks.

It is evident, therefore, that a part of a city telephone system will always be above ground, namely, the short terminal distribution to groups of subscribers, while another and constantly varying part will be temporarily above ground, namely, longer single wires, carried to subscribers so widely scattered that they cannot be grouped so as to be reached by short wires from the permanent terminals. This varying overhead portion should have the continual supervision of some authority other than the telephone company itself, which can demand, at any time when the number of subscribers will justify it, that overhead lines previously permitted shall now be consolidated in a cable, and carried underground to a convenient terminal. This supervision, together with the work of improving from time to time the character and location of terminals, is a work of patient and constant study and of small details in administration. It should be in competent expert hands, and connected with a permanent department of the municipal government.

There are also in large cities the wires of the district telegraph companies, which earn little or nothing, wire and instrument being furnished to the subscriber at a nominal charge, or free, and the revenue of the companies consisting of the fees for messenger service, which are the same, whether the service be

* New York *Electrical Review*.

† Objectionable on other grounds, as already explained.

ordered by wire, mail, or personal application. These] conductors go singly from the central station of each district on all directions and are practically terminal distributing wires from the start. They can rarely be combined in cables, so as to be put underground, even if the conduits were prepared for them. Such conductors should be subject to official inspection and control, confined to house-tops, and carefully so placed that they cannot by any ordinary accident come into contact with high tension conductors.

The conductors of electrical energy in large amounts, for transformation into light, heat and power, present a much more difficult problem, the pressing importance of which will be far greater in the future than it is to-day. The following outline, made as free from technical terms as possible, will perhaps enable the general reader to form a conception of its nature.

Electrical, like all other energy, involves two factors. As a certain amount of heat is contained in a given body at a given temperature, and an equal amount may be contained in another body, smaller or larger, but correspondingly hotter or cooler; or, again, as the energy of a rifle ball moving swiftly may be equal to that of a cannon ball moving slowly; or, as the energy of a slender stream of water falling from a great height may be the equivalent of that of a larger stream with small "head"; so a given amount of electrical energy may be expressed in a certain current with a certain "potential" or intensity, or in a smaller current with higher intensity.*

With a given expenditure of power, we can force through a long pipe either a small quantity of water at high pressure and speed, or a larger quantity at lower pressure and speed. But practically we must suit the size of the pipe to the purpose in view. The larger quantity requires a larger pipe: and if we go beyond a certain relation, the resistance of friction increases until it may finally stop our engine; or (if the engine has an automatic cut-off, and increases its effort to overcome the increased resistance, and is too powerful to be stopped) the water-pipe may burst. Finally, the amount of friction in the pipe depends also upon its material, shape and other conditions, apart from its size or the velocity of the current forced through it.

This familiar analogy presents conditions roughly similar to those of an electrical conductor; but the strain thus produced is not ordinarily a bursting strain, like that of water in too small a pipe. In the case of the incomparably intense and powerful current of lightning, rending effects are included; but the energy of artificial currents is transformed under such conditions into heat; and thus a conductor may be made white-hot by passing through it a current of relatively excessive quantity. This is the principle of the incandescent or "glow" lamps, in which a short conductor of small diameter and inferior conductivity is made to convey a current of relatively large quantity, and thus by its resistance becomes white-hot, although the same current in the larger copper wire on both sides of the lamp is carried without perceptible rise of temperature.

Just as the water-pipe, originally large enough, but becoming deformed or clogged by accident, may then behave like a pipe made too small, so the conductors of "quantity" currents of electricity may be accidentally affected so as to increase the friction of the current at certain points, and to become, at such points, heated even to whiteness. This is not the direct result of imperfect insulation. To recur to the analogy of water, a pipe that leaks is not more, but less, likely to burst, because the leak relieves the bursting-strain; and so a defective insulation, permitting the escape of a part of the electrical current prevents to that extent its transformation into heat. But indirectly, the defective installation of quantity-currents often leads, particularly in house interiors to the dangerous heating of the wires. For instance, a building has been carelessly "wired" by the contractor for incandescent lights. It is subsequently found that, by reason of the imperfect insulation, much of the current escapes into the walls, and the lights are dim. The easiest remedy is to put on more current, in order to give the lamps enough, notwithstanding the leakage, and in this way the parts of the circuit not relieved by leakage may become overheated. Several instances in which those or similar conditions have led to incipient conflagrations are known to the board. The popular impression, therefore, that the low tension, quantity-currents are perfectly safe is erroneous. Whether used for incandescent lighting or for the transmission of power, they carry the potential risk of fire. This can and should be adequately met by a rigorous inspection of the interior, as well as the street installation of such systems. The underwriters' regulations have not been suitable. Some of their regulations have been unnecessary or absurd; others have been fatally deficient. The practice of the first-class electrical companies is usually good, but building contractors are often engaged to "wire" new houses before any arrangements for the actual lighting have been made with this or that company, and their work, once hidden in the walls, is beyond inspection.

For convenience, the quantity currents have been spoken of above as if they were always of low tension. This is not necessarily the case. High intensity and large quantity may be combined in the same current. Currents of sufficient intensity for many arc lights may be carried through incandescent lamps in the same circuit with the arc lamps, and this is sometimes done, particularly in the illumination of industrial establishments, where both kinds of illumination are desired. (The method of reaching a similar result by the use of alternating currents will be described hereafter.) But practically the great incandescent systems (such as the Edison) employ low tension currents. These can be easily operated underground.

Currents of high potential, whatever be their quantity, present dangers of a different kind.

In the first place, just as high pressure on a water-pipe tends to make it leak at all joints, though it may have seemed perfectly tight at lower pressures, so the "potential," "intensity," or pressure of an electrical current increases its tendency to leakage. This is counteracted by "insulation;" that is, by surrounding the conductor with a substance which is a so-called "non-conductor." All these non-conductors are really capable of conducting electricity; they simply do not conduct it freely, and since the electrical current chooses the easiest path, or rather divides itself, among all paths presented, in proportion to their relative ease (as water under pressure divides itself among different ways of escape, or air currents employed in ventilating mines divide themselves among the different air courses), it consequently does not in large proportion adopt a "non-conductor." That no such substance is a theoretically perfect protection, the following explanation will show:—

The so-called "current" of electricity is the result of a disturbance of equilibrium between the two ends of its path. This disturbance of equilibrium is expressed by a difference in "potential," that is, of electrical pressure.

Water flows in the direction of the smaller pressure. If the pressure were equal on all sides, it would stand still. Under ordinary circumstances, the water in a main, pressed from behind by a pump, flows forward. It is true that there may be in the air or earth outside of the main still less pressure than that which opposes the forward movement; but the water does not flow to that space, because the iron of the main and its tight joints are "bad conductors" for water. The pump-pressure may be increased, however, to such an extent that the water can force its way through the main with less effort than it required for it all to go forward. In that case, it will seek the space of lowest pressure surrounding the main. If that space were occupied with a pressure equal to that within the pipe, the water would not seek it at all. In other words, as everybody understands, the difference in pressure inside and outside of the pipe measures the strain to which the pipe is subjected. Its ability to resist that strain increases with the thickness of its material.

The case of electric currents is similar. The general "potential" of the earth is very low—so low as to practically be adopted as the zero of the scale; and hence we may conceive the electric current as striving to reach the earth with an effort proportional to its own intensity. It will take the longer road through its own conductor to an extent determined by the relative resistances of the various possible paths; and these resistances are dependent upon the nature of the substances to be traversed and the length of the path. A naked wire carried on poles is insulated by glass and wood at the points of support, and still more perfectly at all other points by air. If no accidental contact with other objects were possible, and if the air, glass and wood were always dry, naked wires thus strung would be sufficiently insulated; for dry air is one of the best non-conductors known, glass is another, and wood, though inferior to these, is still fairly good. Neither of them is perfect; their resistance is proportional to the length of the electric path through them; and lightning proves that there is a tension, beyond our present means of measurement, at which the electrical discharge may take place, through thousands of feet of "insulating" air, to the earth. But for the highest intensity that human machinery has generated a few feet of air give an ample insulation. Physicists have never been able to make the electric spark pass through more than a few inches of air. Perhaps even one inch of dry air would give more effective insulation than an equal thickness of any other practically available substance. Moisture impairs the insulating quality of air, and moisture collected upon solid non-conducting material may itself constitute a good conductor.

The safe insulation of high tension currents above ground, then, requires to the ordinary protection given by the glass, wood and air intervening between them and the earth, there should be added protection against moisture and against accidental contact with other conductors, among which living bodies may, under certain circumstances, be unfortunately found. Such protection is not adequately given by the thin fibrous covering of the "underwriters'" wire, too often employed in street lighting. After a single season this covering is affected by moisture, and becomes

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* The analogy of hydraulics here employed may be open to objection, on the ground that the word "current" and "resistance" have a technical meaning among electricians, different from that which this analogy would suggest. The precise expression of the proposition above stated would be deduced from the well-known electrical formula: $W = E\,C$, in which W is the energy in watts, E the electro-motive force in volts, and C the current in ampères. It is evident that for the same value of W, the values of E and C may be varied indefinitely so long as their product is not changed.

For the purpose of this report, the analogy with the hydraulic formula is sufficiently accurate, although the further electrical equation

$$C = Q\,T = \frac{E}{R}$$

in which Q is the quantity of electricity in coulombs, T the time in seconds, and R the resistance in ohms, indicates a distinction between "quantity" and "current."

practically worthless. Moreover, every insulating material not absolutely solid and hard, or covered with some shield, may be sawed through by friction of crossed and tangled wires, and thus destroyed locally. Safe overhead installation, therefore, requires not only a thorough protective insulation, but also such choice of position for the wires that they shall not be liable to contact with others—particularly as the result of storms.

When high tension conductors are put underground the difficulty of insulation is indefinitely increased, because the zero potential of the earth is brought so much nearer to the high potential of the current; and the thickness of the protecting insulation, whatever it may be, is correspondingly diminished. The suspended portion of a naked wire between two poles, 20 feet above the earth, is probably 240 times as well insulated as a wire in a subway-duct 2 inches in diameter would be, though the whole duct were filled around the central wire with the best insulating material now known in commerce. For the earth (that is the wall of the duct which would be practically at the earth-zero of potential) would be, in the latter case, only an inch away; and the insulating material would not be superior to an equal thickness of dry air. It has been attempted, with some success, to surround underground conductors with air; and as an auxiliary insulation it is, no doubt, beneficial; but there is difficulty in keeping it dry and it cannot well be relied upon as the sole protection for naked wires. Nor does it prevent their accidental contact with one another. Finally, it may involve, for the accommodation of any considerable number of conductors, more space than could be conveniently given.

The principal evils resulting from the difficulty of insulating high tension underground conductors are two. First, they are liable to fail after brief use, by the sudden destruction of their insulation at single points. This may be the result of original defects in construction or in connections. It is at the joints that the failure most frequently occurs. And one of its most frequent forms is that of the so-called "disruptive discharge" of which more will be said presently. This is undoubtedly often produced by careless management of the dynamo, especially starting or stopping, which may produce a violent electrical disturbance, analogous to the "water-hammer" occasioned in water-pipes by suddenly opening or closing valves, and thus greatly augmenting ordinary strains. Finally, the failure of underground cables may be due to the accumulated effects of slow deterioration of the insulating material under the excessive strain to which it is subjected by the close proximity of the earth-zero of potential. Conclusive proof of this gradual process has not been obtained. It is difficult to obtain, because the usual daily electrical tests of operating companies are not delicate enough to detect it, and because failure, when it, occurs, is local at some weakest or most severely strained point. But the general experience that underground high tension conductors fail within three years, points to such a constantly operating cause; and the fact that, under conditions otherwise alike, the strain upon insulation is much severer underground cannot be successfully denied.

All such failures require the renewal of the section of conductor in which they occur. They may be measurably prevented by care in construction and operation, and they may be retarded by improved quality and increased thickness of insulation. Considered as an element of expense and loss to the electrical companies, and thus indirectly, as enhancing the price and impairing the effectiveness of the service rendered, they constitute the first of the two evils referred to.

The second evil is that this escape of the intense current, being likely to occur at joints, and therefore in manholes, and being usually accompanied with a spark, may ignite explosive mixtures of gas. As already explained, the proper ventilation of the subway will reduce the danger from gas to a minimum. Nevertheless there is more or less risk in carrying currents which *may* thus be discharged with a spark through places were gas *may* have collected, notwithstanding all precautions. No absolute preventive of the disruptive discharge has yet been fully proven in practice, though some ingenious and promising devices have been proposed, to render it harmless in this respect. It can, undoubtedly, be so far avoided by careful installation and management as not to be more frequent underground than overhead; but there is this great difference, that overhead it usually does no more than spoil a piece of conductor, easily renewed, while underground, it may blow up a manhole besides. The board believes that (perhaps on the principle already suggested by one expert, of providing a path for the spark, which might effect the "sparking" outside of the conduit altogether) the dangerous possibilities of the discharge will ultimately be removed. In that event, it will remain merely a commercial injury, and high tension conductors in well ventilated conduits, not containing conductors of other classes, will be safe enough.

Meanwhile the question is thus raised, whether *for such conductors*, it would not be better to use solid conduits, packing the insulated conductors in a mass of asphaltic concrete or other material, which would admit neither gas nor moisture. The board has examined several such systems, and has been favourably impressed with their apparent adaption, at least to special kinds of service. But it is compelled to admit that within the fateful three years (and usually in a much shorter period) they have failed for one reason or another. Certainly they do not permit with facility the making or changing of new connections. Any disturbance of them is likely to destroy the whole system. If a single conductor out of a number thus laid in one mass, should fail, it must simply be abandoned; the replacing of it with another would be impracticable. Finally, all these solid conduits of various concretes are liable to crack somewhere, sooner or later; cracks admit moisture and moisture is rapidly fatal to the insulation.

Open conduits have been successfully operated in cities like Washington, where the wide streets, or some other circumstance, make the danger from gas inconsiderable. In such cases the above considerations may be neglected.

Besides the results of imperfect insulation above discussed, the disturbing effects of induction upon telegraph and telephone wires must be considered. An induced current is set up in any insulated conductor by every change of electrical condition in a neighbouring conductor. The induced current is strongest when the two conductors are parallel, and least (practically nullified) when they are at right angles. This is due to the fact that the induced current is in the opposite direction from the inducing current. If two conductors cross at right angles, the two halves of each tend to produce in the other currents in opposite directions which destroy each other. Similarly, if the outgoing and incoming wires of an electrical circuit be laid closely parallel or twisted together, they will tend to produce in a parallel conductor, presumably equidistant from both of them, two contrary currents, thus measurably neutralising the inductive effect.* Induction shields, to receive the inductive effect, and, partially at least, convey it to the earth, have been proposed. Iron pipe or the lead covering of the underground conductors may serve such a purpose. It is quite practicable in such ways to reduce the effects of induction to a tolerable minimum; and it is probable that overhead installations, where the natural insulation is superior, are more troublesome in this respect than underground ones. But the general practice of electric arc lighting companies, of carrying their wires on extended circuits, so that every conductor exposed to their inductive influence receives the effect of one wire alone, without the counteracting effect of its fellow, will probably have to be stopped. And this is one of the features of installation which should be under public control. For the same reason grounded circuits will probably have to be abandoned for all kinds of electrical service in cities, except, possibly, the telegraph; and complete metallic circuits will have to be substituted—a change which may be made progressively, and under proper expert authority.

(*To be continued.*)

CORRESPONDENCE.

Dynamo Designing.

In a very able and exhaustive article by Professor Jamieson in the ELECTRICAL REVIEW of March 8th, 1889, on dynamo construction, there occurs the following passage:—"As we shall see further on from our trial drawing and calculations, we can get in six turns of wire to each section."

The writer then proceeds to deduce from a formula, of which this six forms a part, the dimensions of the armature and field-magnets of the machine.

Will you or some of your readers kindly tell me how this "six" is obtained? All the rest of the article I can understand, but it seems to me that it is necessary to have this figure six, or some other fixed number, in order to be able to build up the trial drawing and make the calculations to which reference is made.

If you could give me an explanation and especially an instance in actual figures of how this is obtained you would greatly oblige.

Edward Conry.

Melbourne, *December 20th*, 1889.

Quadruplex Telegraphy.

I find on page 488 of your No. 622 for October 25th, 1889, that another student besides myself has been misled by your answer to my 7th question in your No. 615 of the 6th September, page 280.

By "shunt capacity" operators in India understand the capacity applied to the neutral relay in quadruplex, in contradistinction to the "balancing capacity" applied to the artificial or balancing circuit.

Evidently the 2nd question on page 488 of your No. 622 for October refers to the manner of distribut-

* Measurably, perhaps not entirely, since the currents in the contiguous outgoing and incoming wires may not be of equal intensity and quantity, and the strong outgoing current may exercise more inductive influence than the weaker return current can counteract.

ing the capacity in the "balancing circuit," and not in the line circuit as your answer would imply. It seems to me that better static balance would be obtained by spreading out the capacity along the "balancing circuit," instead of applying the capacity to the beginning of it.

On long lines is the differential method of quadruplex superior to that of the bridge?

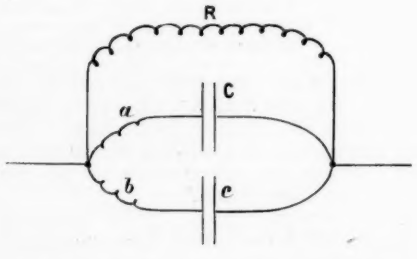
In the bridge method what advantage is it to have—electromagnets forming the arms; the neutral relay in the galvanometer branch; and the two coils of the polarised relay so disposed as to have one in the "line circuit," and the other in the "balancing circuit"?

In practice I have observed that a current from six minotto cells having a resistance of 15 ohms each, sent through a Siemens relay of 500 ohms joined in series with a condenser of 2 m.f. capacity and an insulation resistance of 150 Ω, operates the relay, whereas if the same cells where employed to send a current through the relay, and a dead resistance far less than 150 Ω the relay is unaffected. Why is this, and what is the value of the current operating the relay in the former case?

A Student.

Madras, *December 27th*, 1889.

[As we pointed out in our issue of October 25th, no advantage is found from the use of a shunt condenser applied to the neutral relay, and in this country therefore it is not used. No doubt if the capacity were distributed over the balancing circuit, a better *theoretical* static balance would be obtained, but it is not found that a better *practical* balance is ensured. In England, on the longer quadruplex circuits (about 200 miles with 20 miles of underground work), the condenser is arranged as shown by the sketch:—



R is the balancing resistance; C a condenser with an adjustable resistance, *a*, in its direct circuit; *c* a rather smaller condenser with a fixed resistance, *b*, in its direct circuit.

This arrangement is found to answer all requirements; a more complicated one would lead to endless trouble and loss of time in balancing up, unless managed by very highly skilled telegraphists.

The differential method of quadruplex is superior in every way, both for short and long lines; it requires less current than the bridge system. No advantage whatever is gained by having electro-magnets forming the arms of the bridge, or by arranging the polarised and neutral relay, as you suggest; practical experience has proved that the differential system pure and simple is by far the best. In regard to your experiment with the relay in series with a condenser, the relay is actuated by the momentary inrush and outrush of current which takes place in the condenser when the working key is depressed and raised, the inrushing current moving the tongue to "marking" and the outrush bringing it back to "spacing." Without the condenser you get no "spacing" current, and hence must operate with a bias which is not a sensitive method of working. A comparatively small fall of insulation, however, upsets condenser working, which is not the case with the direct method. In the case of the condenser, the working of the relay is due to an inrush and outrush of 12 micro-coulombs of electricity—*i.e.*, 6 volts × 2 microfarads.—EDS. ELEC. REV.]

Lighting Places of Worship.

Referring to an article in your last issue, headed, "Electric Lighting in Places of Worship," it may not be out of place to say that London is not by any means to the front; towns such as Eastbourne and Hastings can boast of having some of their places of worship lighted with electric lamps for some time past, and, comparing the brilliancy and steadiness of the electric light with that of gas, several to whom I have spoken in both these towns express their highest admiration of the new system, and hope the time is not far distant when electric light will be obtainable at about the same price as gas.

H. Luttrell-Elward.

The Explosion in Sardinia Street.

I notice in your current issue, a statement to the effect that a steam pipe burst at our Sardinia Street station, on Wednesday morning last.

This is incorrect, and I cannot but express regret that no enquiries were apparently made by you to ascertain the facts before the insertion of your remarks.

The cover of a small "blow-off" tank blew off and broke a ladder which was placed over it, but did not destroy part of the roof. Only a few panes in the skylight were broken.

The doors were not blown out as you state, but were damaged by the ladder.

One man received a cut at the back of his head, but will be able to resume work in the course of the present week.

Trusting that you will, in fairness, insert this correction.

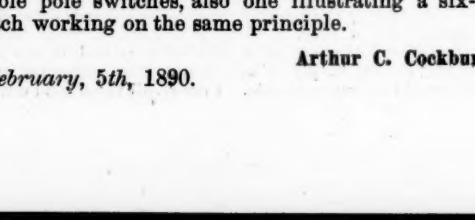
E. Cunliffe Owen, *Secretary.*
The Metropolitan Electric Supply Company.

February 4th, 1890.

[We are pleased to insert our correspondent's letter, but we thought it would be mere waste of time to make enquiries as the daily paper which published an account of the accident stated expressly that no information could be obtained from the company.—EDS. ELEC. REV.]

Double Pole Switches.

Noticing in your issue of last week that you describe and illustrate a double break switch, by Messrs. Woodhouse and Rawson as *new*. I would draw your attention to those made by my firm and patented December, 1888. These switches were shown at the Building Trades' Exhibition, August last, and again at Bingley Hall, Birmingham, and illustrated in Exhibition number of *Electrical Plant;* it has also been illustrated in one of my firm's switch catalogue during the whole of last year.



I have pleasure in sending you blocks of simple double pole switches, also one illustrating a six-way switch working on the same principle.

Arthur C. Cockburn.

February, 5th, 1890.